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Los Angeles

Essays in Trade Credit and International Trade

A dissertation submitted in partial satisfaction

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of Philosophy in Economics

by

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ABSTRACT OF THE DISSERTATION

Essays in Trade Credit and International Trade

by

Santiago Andrés Justel

Doctor of Philosophy in Economics

University of California, Los Angeles, 2020

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When a buyer and a seller meet in the market, both need to decide quantity and price. However, often they also argue when to transfer the payment. In one extreme, the seller may demand early payment before delivering the goods. In the other, the buyer can demand late payment after receiving the products/services. The former is sometimes called *cash in advance*, while the latter is called *trade credit.*

Understanding the use of trade credit is essential because it is one of the main sources of short-term finance for firms. Additionally, since each trade contract specifies prices, quantities, and payment delay, the contract is implicitly defining who is responsible for financing the production and who bears the risk of default, which can itself be a deterrent to trade. My dissertation aims to study some of the novel factors that shape the use of trade credit and shed some light on its effects on a firm's decision to trade.

The first chapter studies the firm-characteristics that shape the use of trade credit decisions in international trade. Trade credit is widely used in firm-to-firm transactions, domestically and internationally. The literature has found that country-specific features, such as interest rates, legal institutions, the rule of law, and capital controls, affect the decision to extend trade credit. The literature has not studied additional features that might explain the trade credit provision in the international context; it also has not proposed additional theories.

To fill this gap, I exploit transaction-level data from Chilean customs. This data set, available for exporters and importers, includes information that describes if a given transaction was paid in advance or paid post-shipment (trade credit). Additionally, I merge this data with firm-level details provided by the Chilean Internal Tax Service.

Using this data, I document new facts. Namely, large firms measured by several metrics are most likely to use trade credit compared to small firms. Motivated by these facts and to guide my empirical strategy, I propose a theory for the use of trade credit. The model has the critical assumption that firms, buyer and seller, may default on their contracts due to liquidity shocks. Depending on the size of the shock, the firm can deplete all its assets, which means it will default. This simple assumption will imply that larger firms will be less likely to default since they have enough assets to absorb the liquidity shock. The predictions of the model are confirmed using regression analysis; therefore, not only country-specific attributes but also firm characteristics affect the contract decision: large exporters (importers) are 15% (40%) more likely to sell (buy) under trade credit compared to small exporters (importers). I also find that a small exporter matched with a large importer is 3-10% more likely to sell under trade credit.

In the second chapter, we propose a theory for the use of trade credit that connects the markup that the exporter charges to the decision of extending trade credit. The key idea is that under pre-payment, the buyer needs to pay the full amount to the seller before receiving the goods. This payment requires liquidity equal to the total invoice, which in turn corresponds to the production cost plus a markup. In contrast, extending trade credit might be cheaper since the seller only needs to cover its production costs in advance, which is lower than the intermediate price due to the presence of markups. If financial intermediation is costly and the lending interest rate is greater than the deposit rate, then this difference in liquidity needs between pre-payment and trade credit affects profits, affecting the decision to provide trade credit.

We test the implications of the theory using Chilean data. First, we construct markup estimates at the firm-product level, using detailed data on inputs and outputs of Chilean plants using the methodology developed by De Loecker, Goldberg, Khandelwal, and Pavcnik (2016). We then use transaction-level Customs data with information on the payment choice to test the model's predictions. We find that trade credit use increases in the markup and that this effect is larger, the bigger the difference between the buyer's borrowing rate and the seller's deposit rate is.

The final chapter proposes and tests an alternative theory. Trade credit is used as a quality guarantee. There are two main facts in existing theories that explain the use of trade credit. First, all these theories focus on explaining the extension of trade credit or not, but not the length of the contract. Secondly, and most importantly, some empirical evidence does not speak to these models. Particularly, most of the existing theories conclude that trade credit is used due to access to cheaper credit or as an enforcement mechanism, then restricting the credit period, say to 30 days maximum, should not alter those incentives. However, the finance literature has found that this type of regulation has effects on the economy. Some authors have found that limiting the trade credit period to 30 days has positive effects, from the seller's perspective, through more competition due to the increase in firm entrance and a decrease in exit rates. However, in the same literature, other papers have shown that these laws also have adverse effects, namely, a reduction in the likelihood and volume of trade.

The previous evidence indicates that the length of trade credit is also essential to understand the decision and its impact on the firm's behavior. Following Long, Malitz, and Ravid (1993), I propose the theory that trade credit serves as a signal for the quality of the product. In a nutshell, the model assumes that when the quality is not observable, but verifiable ex-post, trade credit can serve as a signal of the product's quality. The logic of the theory is that a buyer will not pay the transaction until she is sure that what she bought is what was agreed upon. Additionally, in this model, trade credit maturity serves a quality guarantee. Longer maturities imply that the buyer has more time to verify the contracted quality. This theory has the main prediction that the provision and maturity of the trade credit are positively related to the quality of the product.

To test these predictions, I use a data set from the Chilean Customs. This transaction-level data set has a unique feature: the number of days at which a transaction was paid, on the addition of the usual measures such as destination, price, and quantity. As for quality measures, I will follow two strategies. First, I will use an off-the-shelf methodology that infers quality from prices and quantities, assuming a particular demand elasticity. Secondly, I will focus my attention on a specific industry, wine. For wine, I web-scrapped information of ratings, awards, and retail prices under the assumption that this data captures wine quality.

The data confirms the main predictions of the model. I find that high-quality goods are more likely to be sold under trade credit. Moreover, regarding the other predictions, I find that high-quality products have 20 more days of trade credit, out of an average of 100 days.

The dissertation of Santiago Andrés Justel is approved.

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Chapter 1

Firm Heterogeneity and Trade Finance. Evidence from Chile

Santiago Andrés Justel, UCLA

What shapes the use of trade credit in international trade? Most of the literature focuses on country-specific factors like legal institutions or the rule of law. In this paper, I document some basic facts about the firm-specific factors that contribute to the use of different payment contracts. Then I propose a model of heterogeneous firms that speak to these facts. Under certain assumptions, the model predicts that small firms that export choose prepayment in greater proportion than large firms. Similarly, small importers will prepay more frequently than large importers. My empirical results using transaction-level and firm-level data from Chile support the model predictions.

1.1 Introduction

Modern trade models, such as Melitz (2003), Krugman (1980), and Eaton and Kortum (2002) treat international trade as the result of competition among firms over the world, consumer's taste for variety and firms' productivity. Regardless of the microfoundation for trade, there are three common assumptions of every international trade model. Exporters sell directly to consumers abroad, transactions (transportation and/or payment) is immediate and perfect financial markets. Reality is more complex than that since exporters sell to firms abroad, production, transportation, and payment takes time and finally, financial markets are not perfect. Although papers like Muûls (2015) and Manova (2013) from the empirical perspective and Kohn, Leibovici, and Szkup (2016), Chaney (2016), and Leibovici (2015) from the theoretical side, deal with trade models in an environment with financial restrictions, the most natural financial restriction for exporters is the fact that production and shipment takes time, therefore exporter and importer must agree upon payment conditions. In particular, they can agree on payment before shipment (Cash in Advance), payment after arrival (Open Account) or they can agree through some bank document as payment guarantee (Letter Credit).[1] Each choice leads to additional problems, related to risk sharing and working capital requirements.

Recent papers have worked on this idea, most notably Schmidt-Eisenlohr (2013), Antras and Foley (2015), and Eck, Engemann, and Schnitzer (2015), although these papers mostly rely on indirect measures of international trade credit and its effects or trade credit data for a single firm, they conclude that country-specific institutional factors, like rule of law, availability of credit or contract enforceability shape the payment contract that the exporter chooses.

My contribution to the literature is twofold. First, theoretically, I propose a simple trade credit model with firm heterogeneity. The model relies on two main assumptions. First,

[1] There are also two-part contracts, but in the data Cash in Advance, Open account and Letter Credit are the main ones.

firms can default on their obligations and the probability of default is negatively related to their size. Secondly, in order to pay in advance, or pay for working capital in the case of trade credit, a firm needs to borrow funds facing a similar default risk. So there will be two main forces driving the exporter's trade credit decision: importer's size will affect the default probability and the exporter's size will impact interest rate she faces.

The second contribution of the paper is that I document and test new facts related to the use of trade credit, focusing on firm heterogeneity and dynamics. In particular, under reasonable assumptions, the model implies that size of the firm affects the payment contract, namely, small exporters are more likely to demand prepayment compared to large firms, whereas small importers are more likely to pay in advanced compared to large ones. Moreover, I can go one step further and study exporter-importer match characteristics that shape the use of trade credit. In particular, the model implies that small exporters matched with large importers are less likely to sell under prepayment. Also, the model predicts that prices and the total value of the transaction will be lower under prepayment. Using transaction and firm-level data from Chile, I find empirical support for these predictions. In particular, small exporters are 20-30% more likely to sell through prepayment compared to large firms, also small importers are 50-60% more likely to buy prepaying compared to large importers. Moreover, small exporters matched with large importers are 5-13% more likely to sell through post-payment. Transfers and prices are 5% lower under payment in advance than under post payment.[2]

Additionally, the model will have something to say about the dynamics of contract choice, price and quantities over time. Under particular assumptions, the model predicts that prepayment choice decreases with the tenure of the relationship. Similarly, prices (quantities) decrease (increases) with the age of the relationship. The empirical results also confirm these predictions. Likelihood of a transaction being prepaid is between 2 to 9% lower for a firm with a relationship tenure of 5 years compared to a new exporter, prices decrease between 5

[2]This is an implicit annual interest rate of 20%, assuming that post-payment transactions are paid in 3 months

and 10% for a 5-year relationship.

Similar to this paper, Ahn (2011) and Demir and Javorcik (2018) use transaction-level data for a country to study trade credit. While the former focuses on the institutional factors that affect trade credit, in this case, capital controls. The latter studies how trade liberalization and competition shape trade finance terms. Close to this paper is García-Marín, Justel, and Schmidt-Eisenlohr (2019). In this paper, the authors propose and test a theory that links the markups that the producer charges with the trade credit provision. The idea is that in the presence of markups and costly financial intermediation, the seller might find it optimal to extend trade credit to reduce the total financial costs. Although their work and this paper are similar, I focus my attention on characterizing and explaining both buyer (importer) and seller(exporter) behavior. Also, my model relies heavily on the risk dimension inherent in the provision of trade credit, and not so much in the markup dimension, although my model includes it.

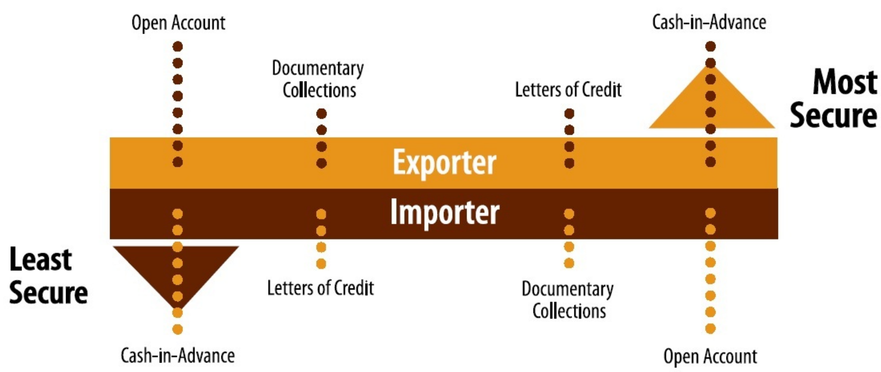
The rest of the paper is organized as follows: the next section discusses the data and shows some motivating facts. In section 3, I provide a stylized trade credit model. Section 4 presents the predictions of the model and in section 5 I test these predictions. Section 6, introduces dynamics into the model, its corresponding predictions, and empirical results. The final section presents conclusions and future agenda.

1.2 Definitions and Data

1.2.1 Payment contracts

In international trade, there are mainly four ways of paying a given transaction. Payment after shipment/arrival, which implies the exporter is giving credit to the importer, this is referred to Open Account (OA). The other extreme is the case where the importer pays in advance, which is known in the literature as Cash in Advance (CIA). In the middle, banks can intermediate through documentation that acts as a payment guarantee. One type of mechanism is called, Letter of Credit (LC), that is an arrangement where an issuing bank (usually importer's bank) unconditionally guarantees to pay the exporter's bank when the goods are delivered. Alternatively, there is the Documentary Collection (DC), which is very similar to the letter of credit, but without any guarantee. Figure 3.7 summarizes the types of contracts and their relationship with risk.

Figure 1.1: Payment methods and risk



To study these contracts, I use transaction-level data from the Chilean customs from 2003-2015. This dataset includes the firm's tax number, 8-digit HS product code, destination and, most importantly, a variable that describes how the transaction (export/import) was paid. In particular, if it was paid in advance (CIA), paid post-shipment (OA) or with some bank documentation (LC/DC). Two important remarks. First, I cannot separate DC and LC, since both are in the same category in the data. Secondly, and more importantly, although there is the possibility of two-part contracts, e.g. 20% paid in advance and 80% paid after arrival, in the data these arrangements are minimal,[3] so I will focus my attention on the standard methods of payment.

[3]Just to give a sense of the how small are these two-part contracts, on average 0.2% and 0.7% of exports and imports respectively were sold under these contracts

1.2.2 Aggregate facts

I present some facts at the aggregate level. In the next section, I will focus on firm heterogeneity.. Table 1.1 shows the shares of each contract counting just transactions or weighting them by value.

Table 1.1: Shares by type of contract. Sample: 2003-2015

	Exports			Imports		
	CIA	DC/LC	OA	CIA	DC/LC	OA
Transaction	7.3	3.0	87.0	21.7	7.1	68.8
Value	2.7	12.4	84.7	12.6	9.8	77.0
			No Mining			
Transaction	7.3	2.8	87.1	21.8	7.1	68.7
Value	4.1	8.1	87.3	12.8	10.4	76.3

Clearly, OA is the predominant type of payment for exporters and importers, even if exclude the mining sector in Chile (that represents 40% of the value of exports), it is the case that, in general, exporters tend to give credit and importers tend to receive credit. Table 2 presents some additional statistics from the data.

Table 1.2: Summary Statistics

	Exporters			Importers		
	Mean	Min	Max	Mean	Min	Max
Firms per year	7525	6743	8125	34544	27022	40881
Destinations per firm per year	12.45	1	77	6.91	1	86
Transactions per firm per year	76.98	1	22928	75.26	1	393046

1.2.3 Firm-specific facts

In this section, I present the main motivation of this paper, namely, firm-specific facts regarding trade finance. To study this, I merge the Customs data with firm-level information from the Chilean Tax Service (SII). This dataset goes from 2005 to 2015 and includes firm-specific information like industry, number of workers, sales bracket and equity.

Fact: Small exporters/importers choose CIA contracts more than larger firms.

Figure 1.2 and 1.3 show this fact. I measure size as total annual sales[4]

Figure 1.2: Exports share. Size measured as revenue. PST=OA+LC/DC

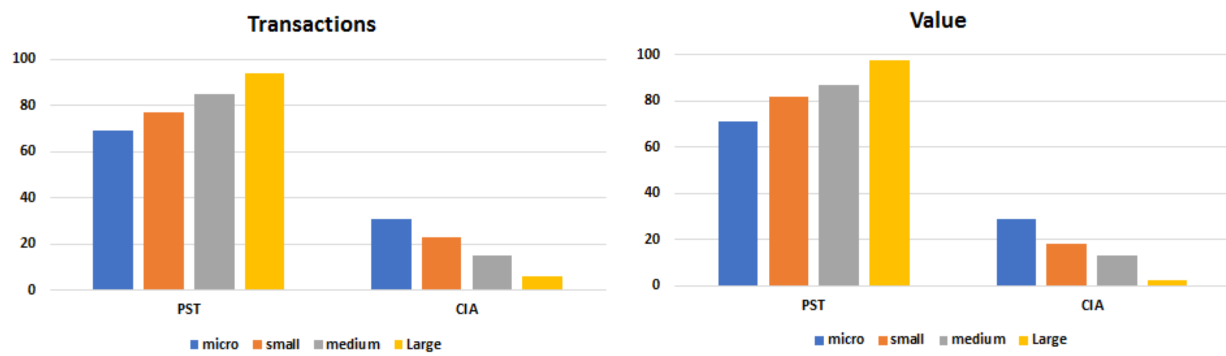
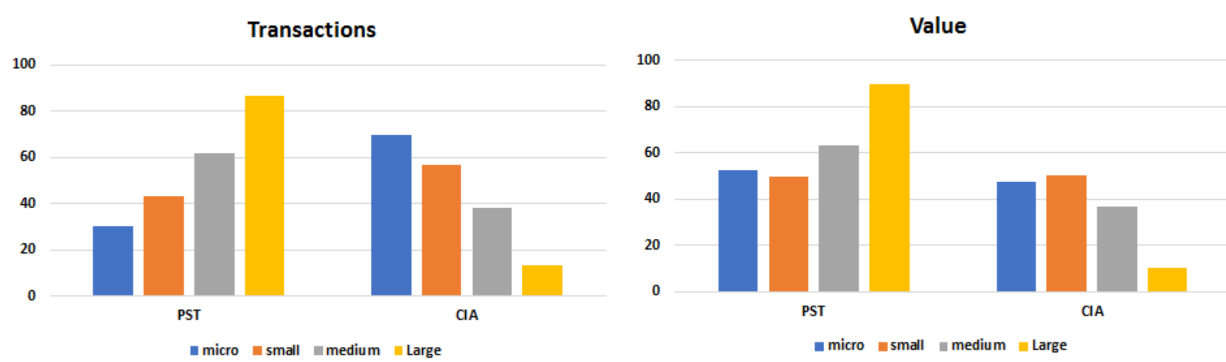


Figure 1.3: Imports share. Size measured as revenue. PST=OA+LC/DC



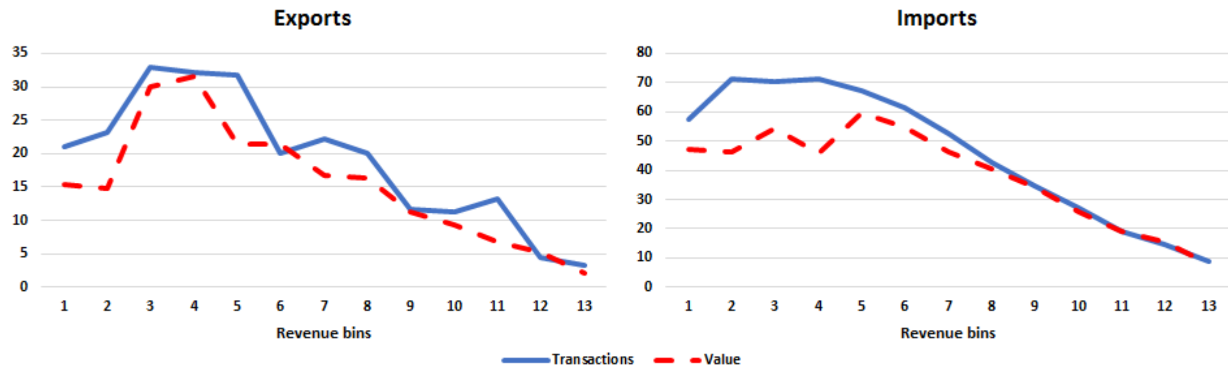
This fact is very robust to the use of other metrics for size such as the number of workers, total equity, total exports/imports. In Appendix A, I show similar graphs for alternative metrics of size and productivity. The Chilean IRS does not report total sales publicly, but they do report if a particular firm belongs to a sales bracket, with 13 brackets in total. Figure 1.4 shows the share of CIA used in each category.

Additional evidence can be found in surveys like the Small Business Exporting Survey[5] indicates that one of the main challenges when selling goods abroad is the risk of not being paid. Moreover to tackle this issue exporters demand prepayment. In summary, evidence points out that size plays an important role in the decision of trade credit.

[4]Micro corresponds to total annual sales less than $100000, Small less than $1000000 and Medium less than $4000000

[5]See the link http://www.nsba.biz/wp-content/uploads/2016/04/Export-Survey-2016-Final.pdf

Figure 1.4: CIA share



1.3 Model

Motivated by these facts, I introduce a partial equilibrium model of international trade with trade finance similar to Schmidt-Eisenlohr (2013) and Antras and Foley (2015).

1.3.1 Environment

I consider $d = 1, 2..., D$ countries. Each country is populated by L_d agents with identical preferences. Finally, each economy has two types of risk neutral firms: producers, who can produce, sell domestically and abroad and importers, who buy from foreign exporters and sell domestically. Exported goods take one period to arrive at the destination. Finally, there is limited commitment. In particular, for simplicity I will assume that exporters always will honor their contracts to importers, importers may default on theirs.[6] Having said that, both importers and exporters may default on their banks.

1.3.2 Preferences

Each consumer has preference CES preferences over a continuum of goods.

[6]This is to keep notation and results clean, I can assume, as in Schmidt-Eisenlohr (2013) and Antras and Foley (2015), that both exporter and importers can default on their contracts. Assuming this will modify slightly the implications of the model.

$$Q = \left[\int_{\omega \in \Omega} q(\omega)^{\frac{\sigma-1}{\sigma}} d\omega \right]^{\frac{\sigma}{\sigma-1}},$$

Given a domestic variety ω, this implies the following domestic and foreign demand curves:

$$q_i^d(\omega) = \left(\frac{p(\omega)}{P_i} \right)^{-\sigma} \frac{I_i}{P_i} \tag{1.1}$$

$$q_{ij}^f(\omega) = \left(\frac{p(\omega)}{P_j} \right)^{-\sigma} \frac{I_j}{P_j}, \tag{1.2}$$

Where I_i represents the income of country i. Consumers also supply one unit of labor inelastically.

1.3.3 Technology and trade

Producers

Without loss of generality, I will focus the analysis on one country, that I will call Home h, and its exporters (and importers) who sell/buy to country j. As in Krugman (1980) and Melitz (2003), each producer is a monopolist for particular variety. To access the foreign market they need to pay a fixed cost F each period. Each producer, indexed by f, face a firm-specific constant marginal cost c to produce drawn from a distribution $H(c)$ with support $[0, \infty]$. Marginal cost is drawn at entry and is fixed over time. Additionally, whenever a producer asks for a credit, they will face a cost shock λ next period. These shocks are i.i.d. and drawn from a commonly known distribution $F(\lambda)$. I will assume that the expected value of this shock is zero. This shock will play a role in the default decision of the firm.

Although I will not focus on them, foreign producers face a similar problem.

Foreign Importers

Home producers cannot access directly the final consumer abroad, so they have to meet a foreign importer in the foreign country in order to export. These importers are basically retailers, they buy from abroad and sell domestically. Similarly, importers will face an i.i.d. cost shock λ^* drawn from a publicly known distribution $G(\lambda^*)$ with an expected value of zero. This shock will matter whenever the importer has an obligation to a bank or an exporter. Domestic importers also face a similar problem.

1.3.4 Trade Finance

Contract

Because of the time delay and the potential default on a credit, once home exporter and foreign importer are matched they must decide quantities, total payment, and the particular contract. Following the presented evidence I will focus on the two extremes of the trade credit. There will be two available contracts: CIA contract in which, the importer pays in advance the agreed transfer (T^{CIA}) for which he must take a loan, the exporter then produces and ships the contracted quantity of the good (q^{CIA}), product arrives next period, revenues are realized, cost shock λ^* is realized and importer repays loan back if possible given the shock.[7] If the shock is large enough, the importer will not be able to pay the loan back. Another option will be the OA contract, in this case, the exporter will produce and ship and quantity q^{OA} of the good, incurring in the corresponding costs. In order to pay for these costs, the exporter must take a loan. Next period, the importer receives the goods, revenues are realized, shock λ^* is observed, then conditional on this shock and revenues, the importer will honor the contract and pay T^{OA}. In this case, exporter receives the transfer, but she will also face a shock λ, that will affect the probability of paying the loan back. If the importer does not pay back, the exporter may still pay back the loan with own funds.

[7] This shock is akin to a negative demand shock.

Exporter and importer have wealth N and N^* respectively that can potentially be used to pay back a loan or trade credit if needed.

To summarize, the timing is:

1. Unmatched Exp and Imp are matched with prob. s.

2. Cost c, income I_j, distributions F and G, wealth N and N^* are observed. Exp pays cost F if (expected) profits> 0.

3. Exp offers one spot contract from $\{q_c, T_c\}_{c=\{CIA,OA\}}$

4. Imp accepts or rejects contract c.

5.a If $c = CIA$, Imp pays T^{CIA} with a loan from a bank with an interest rate of r^*, Exp produces q^{CIA}, product arrives next period, Imp sells goods, revenues R and shock λ^* are realized and importer pays the loan back with probability:

$$\theta^*_{CIA} = P(R - (1 + r^*)T^{CIA} + N^* > \lambda^*) \tag{1.3}$$

5.b Exp produces q^{OA}, paying the corresponding costs with a loan from a bank with an interest rate r. Product arrives next period, Imp sells goods, revenues R and shock λ^* are realized and with prob $\theta^*_{OA} = P(R - T^{CIA} + N^* > \lambda^*)$ Imp pays T^{OA}.

6.b Regardless if the importer paid, Exp faces a shock λ. Then, exporter will payback with probability:

$$\theta_{OA} = \theta^*_{OA} P(T^{OA} - (1+r)cq^{OA} + N > \lambda) + (1 - \theta^*_{OA})P(-(1+r)cq^{OA} + N > \lambda), \tag{1.4}$$

where θ^*_{OA} is defined by:

$$\theta^*_{OA} = P(R - T^{OA} + N^* > \lambda^*)$$

One of the key aspects of the model is the introduction of these cost shocks, which make the default probability to exporters or to banks a decreasing function of exporter size N or importer size N^*. Moreover, as I will show, because of perfect competition in the banking sector, interest rate r and r^* will also be affected by size.

1.3.5 Profit Maximization

Domestic Profits

Since in the domestic market there is no lag nor frictions, the profit maximization problem is standard. The firm solves:

$$\max_p pq - cq$$
$$\text{s.t.} \quad q = p^{-\sigma} P_i^{\sigma-1} I_i$$

which implies:

$$p(c) = \frac{\sigma}{\sigma-1}c \tag{1.5}$$
$$\pi_i^d(c) = \frac{1}{\sigma}\left(\frac{\sigma}{\sigma-1}c\right)^{1-\sigma} P_i^{\sigma-1} I_i \tag{1.6}$$

Since I am mainly interested in international trade and, as stated, there are no frictions in the domestic market, I will not further analyze these profits.

Foreign Profits

For generality, I will assume that when exporter and importer decide quantities and transfers in each contract, they do it through Nash bargaining.[8] Let me denote as β the

[8] Bernard and Dhingra (2015) assume something similar, claiming that the ability to reject the proposed contract enables a firm to extract some of the surplus. Moreover, this bilateral negotiation avoids double marginalization.

bargaining power of the exporter.

CIA Contracts

In a prepayment contract, the importer must ask for a loan to a bank to pay the transfer T^{CIA}. For any foreign competitive bank, the return for each dollar loaned must be equal to the risk-free interest rate, using (1.3) we can define the interest rate r^* as:

$$1 + \rho^* = \theta^*_{CIA}(1 + r^*), \tag{1.7}$$

where ρ^* is the risk-free interest rate abroad. With that, discounted profits of an importer before the cost shock λ^* are:

$$\pi^{CIA}_{Imp} = \frac{pq}{1 + r^*} - T^{CIA} \tag{1.8}$$

The profits for the exporter are straightforward:

$$\pi^{CIA}_{Exp} = T^{CIA} - cq^{CIA} \tag{1.9}$$

So, the Nash bargaining problem is:

$$\max_{T} \left[\pi^{CIA}_{Exp}\right]^{\beta} \left[\pi^{CIA}_{Imp}\right]^{1-\beta}$$

Then exporter chooses q s.t.

$$\max_{q} T^{CIA}(p, q) - cq$$
$$\text{s.t.} \quad q = \left(\frac{p}{P_j}\right)^{-\sigma} \frac{I_j}{P_j}, (3) \quad \text{and} \quad (7)$$

where $T^{CIA}(p, q)$ is the solution from the Nash bargaining.

This problem can be solved using backward induction and the fact that Nash bargaining implies a surplus sharing rule, thus respective discounted profits can be redefined as:

$$\pi_{Exp}^{CIA} = \beta S^{CIA} \tag{1.10}$$

$$\pi_{Imp}^{CIA} = (1-\beta) S^{CIA}, \tag{1.11}$$

where $S^{CIA} \equiv \frac{pq}{1+r^*} - cq$ is the total surplus of the transaction. Moreover, using (3) and (7) and the definition of profits, we can define S^{CIA} as the solution of:

$$\begin{aligned} S^{CIA} &= \max_q \frac{\theta_{CIA}^*}{1+\rho^*} pq - cq \qquad (1.12) \\ \text{s.t.} \quad q &= \left(\frac{p}{P_j}\right)^{-\sigma} \frac{I_j}{P_j} \\ \theta_{CIA}^* &= G\Big((1-\beta) S^{CIA} \frac{1+\rho^*}{\theta_{CIA}^*} + N^*\Big) \end{aligned}$$

Where the last equality comes from the fact that the probability of honoring the contract is defined by the probability that next period's profits ($(1+r^*)\pi_{Imp}^{CIA}$) plus the assets of the importer must be greater than the shock. So, the CIA contract is defined by q^{CIA} as the arg max of the surplus and the transfer $T^{CIA} = \beta S^{CIA} + cq^{CIA}$.

OA Contracts

In this case, the exporter needs a loan to pay for the working capital. Since domestic banks are also competitive, using (1.4) we can define the interest rate r as:

$$1+\rho = \theta_{OA}(1+r), \tag{1.13}$$

where, ρ is the domestic risk-free interest rate. Now, we can express future profits for importer before the shock as:

$$\pi_{Imp}^{OA} = pq - T \tag{1.14}$$

Similarly, expected (discounted) profits for the exporter are given by:

$$E(\pi^{OA}_{Exp}) = \frac{\theta^*_{OA}}{1+r}T - cq \tag{1.15}$$

Notice, that given the structure, the exporter must take into account the possibility of the importer defaulting on the trade credit. Then, Nash bargaining problem is:

$$\max_{T} \left[E(\pi^{OA}_{Exp})\right]^{\beta} \left[\pi^{OA}_{Imp}\right]^{1-\beta}$$

Then producer chooses q

$$\begin{aligned} &\max_{q} \frac{\theta^*_{OA}}{1+r}T^{OA}(p,q) - cq \\ \text{s.t.} \quad & q = \left(\frac{p}{P_j}\right)^{-\sigma}\frac{I_j}{P_j}, (4) \quad \text{and} \quad (13) \end{aligned}$$

where $T^{OA}(p,q)$ is the solution from Nash bargaining. Similarly as before, sharing rule applies, then, with a slight abuse of notation, discounted profits for each agent are:

$$\pi^{OA}_{Exp} = \beta S^{OA} \tag{1.16}$$

$$\pi^{OA}_{Imp} = (1-\beta)S^{OA}, \tag{1.17}$$

where $S^{OA} \equiv \frac{\theta^*_{OA}}{1+r}pq - cq$ is the total expected surplus of the transaction. Finally, using analog expressions that in the CIA contract case, I can define S^{OA} as the solution of:

$$S^{OA} = \max_{q} \frac{\theta^*_{OA}\theta_{OA}}{1+\rho}pq - cq \tag{1.18}$$

$$\text{s.t.} \quad q = \left(\frac{p}{P_j}\right)^{-\sigma}\frac{I_j}{P_j}$$

$$\theta^*_{OA} = G\Big((1-\beta)S^{OA}\frac{1+\rho}{\theta^*_{OA}\theta_{OA}} + N^*\Big)$$

$$\theta_{OA} = \theta^*_{OA}F\Big((\beta S^{OA} + cq^{OA})\frac{1+\rho}{\theta^*_{OA}\theta_{OA}} - \frac{1+\rho}{\theta_{OA}}cq^{OA} + N\Big) + (1-\theta^*_{OA})F\Big(-\frac{1+\rho}{\theta_{OA}}cq^{OA} + N\Big)$$

As in the CIA contract, the third equation is the probability of the importer honoring the contract and is related to the probability of future profits and assets being greater than the shock. In a similar fashion, the last equation defines the producer's probability of paying back to the bank, the first part corresponds to the profits when importer pays back the transfer and the second part when importer defaults. Then, the OA contract is defined by q^{OA} as the maximizer of the problem above and the transfer $T^{OA} = (\beta S^{OA} + cq^{OA})\frac{1+\rho}{\theta^*_{OA}\theta_{OA}}$. Notice that if $\beta = 1$, T^{OA} is equal to the total revenue and if $\beta = 0$, T^{OA} is such that the expected transfer is equal to total cost.

1.3.6 Contract choice and entry to export

Contract choice

To analyze the contract decision exporters need to compare profits between both options. The contract choice is given in the following proposition.

Proposition 1. *If $S^{CIA} \geq S^{OA}$, CIA contract will be used. Equivalently, CIA contract will be preferred if*

$$\frac{1}{1+r^*} \geq \frac{\theta^*_{OA}}{1+r},$$

in any other case, OA contract will be used.

Proof. Given the structure, the contract choice depends on the profits of the exporter and because of surplus sharing rule, comparing profits is equivalent to compare S^{CIA} and S^{OA}. As for the second part of the proposition, the result comes directly as an application of the envelope theorem. ■

This result is similar to the one obtained by Schmidt-Eisenlohr (2013) and Antras and Foley (2015), the main difference is that default probabilities and interest rates are endogenous and depend on producer/importer size, N and N^* respectively. So the condition to use trade credit in equilibrium is:

$$\frac{1}{1+r^*(N^*)} < \frac{\theta^*_{OA}(N,N^*)}{1+r(N,N^*)}$$

Because under CIA has no default risk for the exporter, CIA will always be used, as opposed to OA. The following proposition describes further this idea

Proposition 2. *If $\rho^* < \rho$, CIA will be used always regardless of the firm size. Alternatively, if $\rho^* > \rho$, for sufficiently large exporter and importer, OA will be preferred.*

Proof. It is easy to see that if N and N^* are large enough, default probabilities for both exporter and importer are close to zero, regardless of the contract. Equivalently

$$\theta_{OA}(N,N^*), \theta^*_{OA}(N,N^*), \theta^*_{CIA}(N^*) \approx 1$$

This, in turn, implies that

$$r^*(N^*) \approx \rho^* \quad \text{and} \quad r(N,N^*) \approx \rho.$$

Then, using condition from Proposition 1, this implies that large firms will use OA contracts if

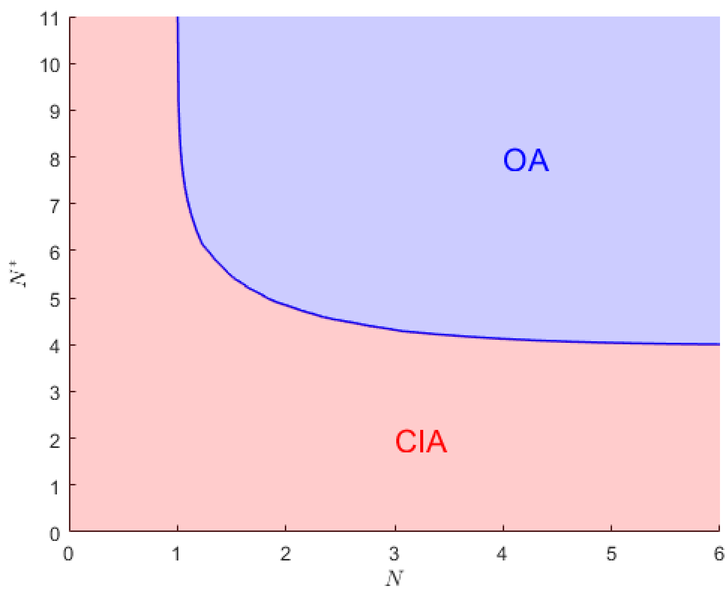
$$\frac{1}{1+\rho^*} < \frac{1}{1+\rho} \Longleftrightarrow \rho^* > \rho$$

■

The intuition is clear if credit is cheaper abroad than locally, the exporter will prefer to ask for prepayment, regardless of his size, since it is cheaper for an importer to ask for credit than for an exporter, once we take into account the default probability of the importer. So, at its core, in this model, the decision between prepayment and trade credit depends mainly on the interest rate differential.

For example, assuming $\rho^* > \rho$, figure 1.5 shows the contract choice as a function of exporter and importer size and it is the first testable prediction of the model, the relationship between size and contract choice.

Figure 1.5: Policy function



Entry to export

Defining the profits of an exporter with size N when matched with an importer with size N^* as

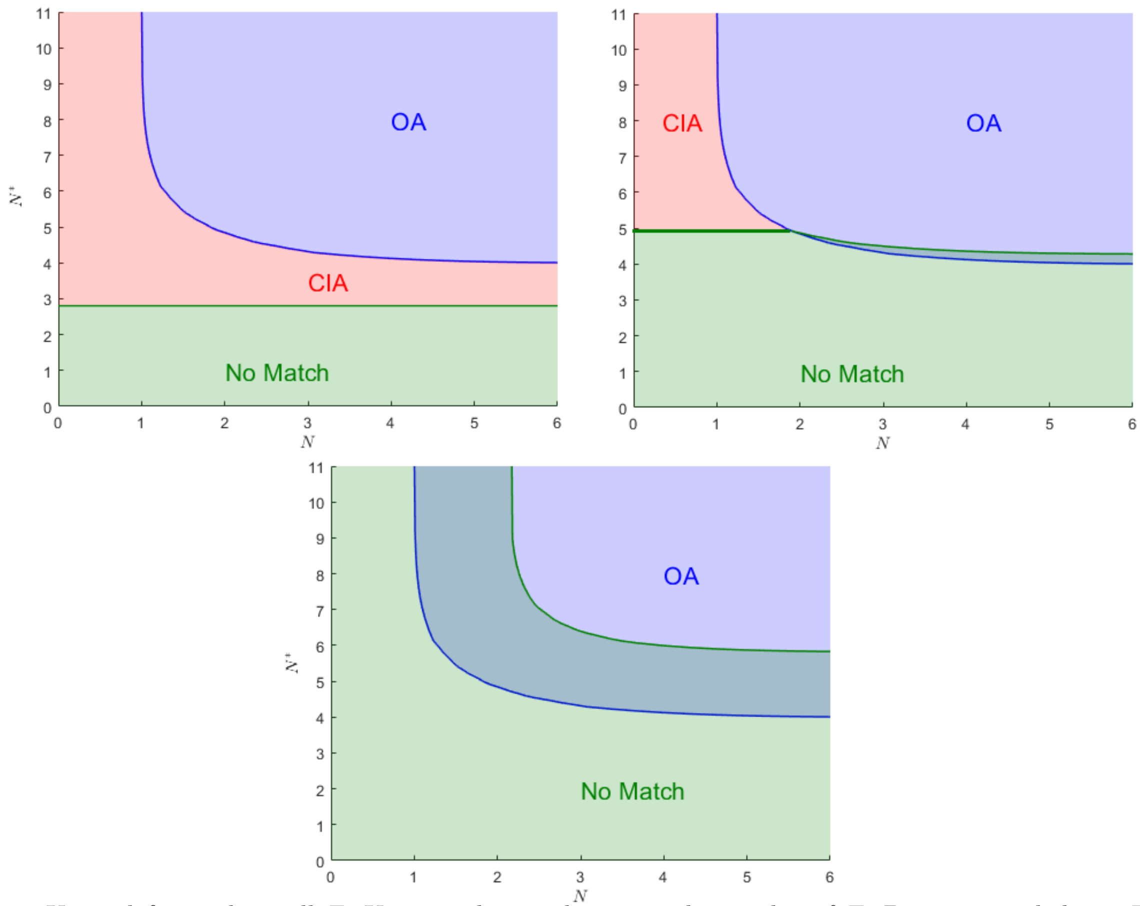
$$\pi_{Exp}(N, N^*) \equiv \max\{\pi_{Exp}^{CIA}(N^*), E[\pi_{Exp}^{OA}(N, N^*)]\},$$

The exporter will accept the match if:

$$\pi_{Exp}(N, N^*) \geq F \tag{1.19}$$

Assuming that OA contracts are used, depending on the size of the fixed cost F, there will be three cases: 1) For small F, only CIA contracts will be affected, so exporters will not sell when matched with very small importers; 2) As F increases, small exporters matched with large importers will choose CIA, otherwise they will either choose OA or not be matched and 3) For F large enough, exporters and importers will only choose OA when they are big enough, otherwise will not trade. Figure 1.6 describes graphically this result.

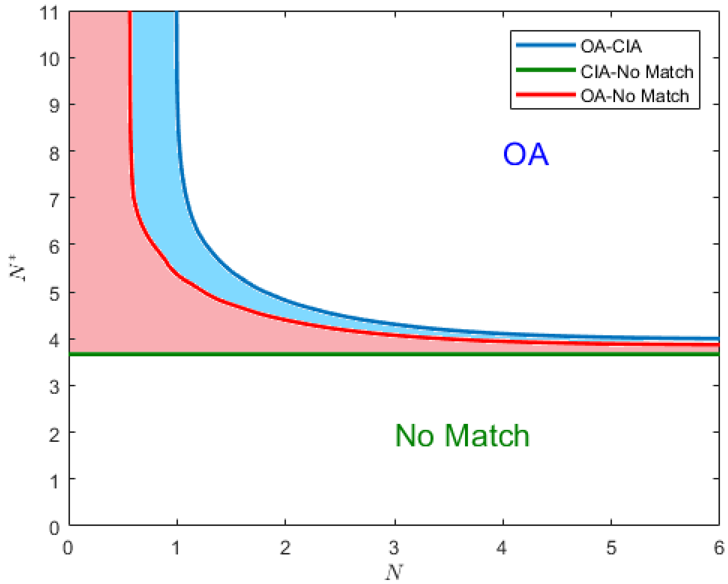
Figure 1.6: Policy function for different values of fixed cost



Note: Upper left panel: small F. Upper right panel: intermediate value of F. Bottom panel: large F. Blue line represents the decision line between OA and CIA that is independent of the value of F

An alternative interpretation of the bottom panel of figure 1.6 is that in absence of CIA contracts, meaning exports can only be done through OA, fewer transactions will be conducted overall. So, CIA contracts enable part of the international trade that otherwise would be impossible. Figure 1.7 shows how the decision rules will change if transactions were conducted only under OA. The red region is the trade loss if CIA is not allowed.

Figure 1.7: Policy function for different values of fixed cost



Note: Red region is the trade loss. Blue region corresponds to a region where transactions previously were paid under CIA and now are OA.

This conclusion is similar to the one obtained by Eck, Engemann, and Schnitzer (2015), where they show that producers that transact under CIA are more likely to export.

1.4 Predictions

In this section, based on the proposed model, I formulate a set of testable predictions relating contract choice and size and the relationship between total transfer/price and contract choice.

Proposition 3. *If $\rho^* > \rho$.*

1. *Likelihood of a transaction being under OA increases with exporter size.*

2. *Likelihood of a transaction being under OA increases with importer size.*

3. *Small exporters matched with large importers are more likely to sell under OA.*

Proof. For an exporter to be indifferent between OA and CIA contract it must be the case that $S^{CIA} = S^{OA}$ or equivalently:

$$\frac{\theta^*_{CIA}(N^*)}{1+\rho^*} = \frac{\theta^*_{OA}(N,N^*)\theta_{OA}(N,N^*)}{1+\rho} \tag{1.20}$$

Then the decision boundary between OA and CIA is given by the pair (N, N^*) such that solves the previous equation. It is easy to check that at the boundary, $\theta^*_{CIA} = \theta^*_{OA}$, so the previous condition can be defined as the pair (N, N^*) that solves:

$$\frac{1+\rho}{1+\rho^*} = \theta_{OA}(N,N^*) \tag{1.21}$$

Notice, as before, that this solution exists as long as $\rho^* > \rho$. For 1) keeping N^* constant, if N increases $\frac{1+\rho}{1+\rho^*} < \theta_{OA}(N,N^*)$ then OA will be preferred, so larger exporters are more likely to choose OA contracts. As for 2), up to a first order (ignoring surplus changes), a small change in N^* for a given $\bar{N}$ at the decision boundary implies that the LHS of (20) changes by:

$$\frac{\theta^{*'}_{CIA}(N^*)}{1+\rho^*} = \frac{g\Big((1-\beta)S^{CIA}\frac{1+\rho^*}{\theta^*_{CIA}} + N^*\Big)}{1+\rho^*},$$

where $g \equiv G'$. Similarly, the direct effect of a change in N^* in the RHS of (20) is:

$$\frac{\partial}{\partial N^*}\left[\frac{\theta^{*'}_{OA}(\bar{N},N^*)\theta_{OA}}{1+\rho}\right] = \frac{g\Big((1-\beta)S^{OA}\frac{1+\rho}{\theta^*_{OA}\theta_{OA}} + N^*\Big)}{1+\rho}\left[\theta_{OA} + \theta^*_{OA}K\right],$$

where $K = F\Big((\beta S^{OA} + cq^{OA})\frac{1+\rho}{\theta^*_{OA}\theta_{OA}} - \frac{1+\rho}{\theta_{OA}}cq^{OA} + \bar{N}\Big) - F\Big(-\frac{1+\rho}{\theta_{OA}}cq^{OA} + \bar{N}\Big)$, clearly $K > 0$. Once again, at the border, surpluses are equal, (20) and (21) still hold, then:

$$\frac{\partial}{\partial N^*}\left[\frac{\theta^{*'}_{OA}(N^*)\theta_{OA}}{1+\rho}\right] - \frac{\theta^{*'}_{CIA}(N^*)}{1+\rho^*} > 0$$

This implies that at the decision border, if N^* increases, up to a first order, RHS of (21) increases faster than the LHS, this means that if a producer is indifferent between CIA and OA, when size of the importer increases, the exporter will prefer OA over CIA because S^{OA} increases more than S^{CIA}. Finally, for 3), since at the border $\theta_{OA}(N, N^*)$ is increasing in both arguments, it must be the case that the policy function $N^*(N)$ obtained from (21) is decreasing in N, which in turn implies that small producers matched with large importers will prefer OA. ■

Proposition 3 is the first testable prediction that relates to size and contract choice. According to the model, there is a negative relationship between size and the use of CIA, this result contrasts with the one found by Eck, Engemann, and Schnitzer (2015) where they find that CIA is positively related to size. The authors argue that this is due to bargaining power, although they do not measure directly trade finance.

Additionally, the model has predictions regarding prices and transfers.

Proposition 4. *If $\rho^* > \rho$, for a given producer selling to or buying from a firm in country j*

1. *Conditional on q, $T^{OA} > T^{CIA}$.*

2. *Conditional on q, unit value, $\frac{T}{q}$, under OA is greater than under CIA.*

The proof of this proposition can be done easily just comparing the expressions of T for each contract and including the condition that quantities under both contracts are the same. The intuition is as follows since OA contract implies receiving the transfer next period with default risk, T^{OA} must be larger than T^{CIA}. The second part of the proposition is straightforward using the same comparison as for 1) and dividing by q. This is saying that prices adjust for risk and interest rates, thus $p^{OA} > p^{CIA}$

1.5 Empirical tests

1.5.1 Size and payment contract

To test the predictions 1 and 2 from Proposition 3, I will estimate the following equation

$$I(CIA_{fdpt} = 1) = \beta Y_{ft} + \mu_{dt} + \gamma_{it} + \varepsilon_{fpdt} \tag{1.22}$$

where the LHS is an indicator equal to 1 if transaction from a firm f to/from destination d of a product p at year t. Y_{ft} is a measure of size/productivity, μ_{dt} and γ_{it} are fixed effects at destination$\times$ year and industry $\times$ year respectively.

Figure 1.8 shows the result when I ran the regression (1.22) using the actual 13 categories of size given by the Chilean Tax Service (expressed as the midpoint for the tax bracket in US dollars).

Figure 1.8: Likelihood of CIA over size

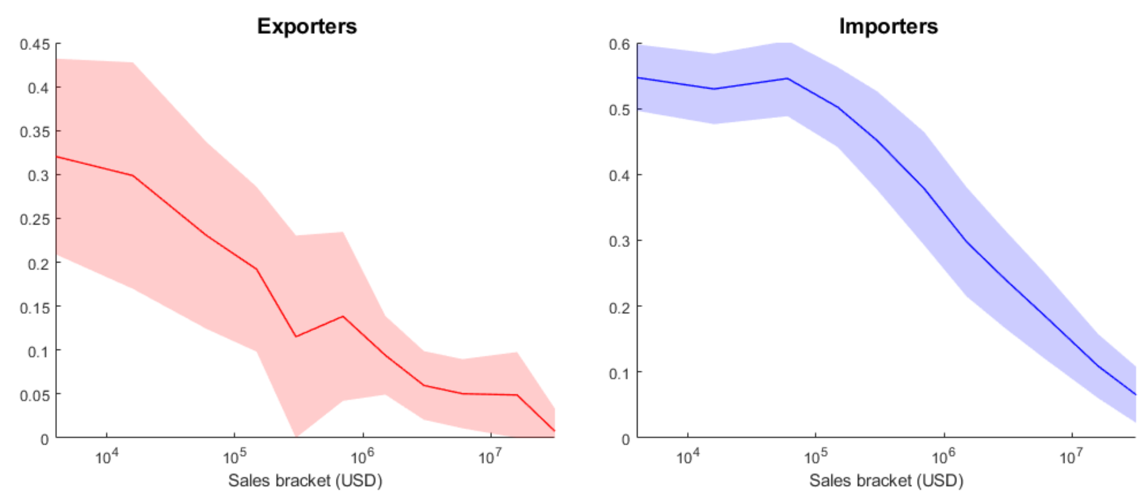


Table 1.3 shows estimations of equation (1.22) for different measures of size and productivity for exports. The last column corresponds to a subsample of firms matched to the Manufacturing Survey (ENIA) from 2003 to 2007. In this sample, I can compute productivity using the method proposed by Levinsohn and Petrin (2003). As it can be seen, small(less productive) firms are more likely to sell under CIA.

Table 1.3: Exports data. Sample 2005-2015. CIA v/s OA

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Micro	0.222***						
	(0.0458)						
Small	0.116***						
	(0.0397)						
Medium	0.0499***						
	(0.0120)						
log(Emp)		-0.00887*					
		(0.00502)					
log(Equity)			-0.0136**				
			(0.00552)				
log(tot Exp)				-0.0213***			
				(0.00569)			
log(Exp/Emp)					-0.0135***		
					(0.00319)		
Age						-0.00258***	
						(0.000852)	
log(z)							-0.0148***
							(0.00441)
Observations	6084500	5802016	5435850	6084500	5802016	6083861	741068
R^2	0.260	0.259	0.270	0.267	0.261	0.254	0.156

Robust standard errors are clustered at firm and at country level
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.010$

Similarly, table 1.4 shows estimations of equation (1.22) for different measures of size and productivity for imports. Column (4) and (6) corresponds to a measure of productivity, in the first case, I control for importers that also export, so I compute total export divided by labor. The final column is as before, a subsample of firms matched to the Manufacturing Survey (ENIA) from 2003 to 2007. In this case, small(less productive) firms are more likely to buy under CIA.

Table 1.4: Imports data. Sample 2005-2015. CIA v/s OA

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Micro	0.460***						
	(0.0246)						
Small	0.340***						
	(0.0250)						
Medium	0.195***						
	(0.0252)						
log(Emp)		-0.0527***					
		(0.00684)					
log(Equity)			-0.0552***				
			(0.00540)				
log(tot Imp)				-0.0624***			
				(0.00617)			
log(Imp/Emp)					-0.0105***		
					(0.00319)		
Age						-0.0116***	
						(0.00174)	
log(z)							-0.0321***
							(0.00754)
Observations	26158359	25289710	24577327	26158359	16761871	26153080	761116
R^2	0.344	0.323	0.349	0.361	0.331	0.3022	0.156

Robust standard errors are clustered at firm and at country level
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.010$

As tables 3 and 4 show, the relationship between size and prepayment is very robust, even when controlled by industry and destination. In particular, small exporters are 10-20% more likely to sell under CIA compare to large firms. Similarly, small importers are 30-45% more likely to buy prepaying compared to large importers.

Finally, for prediction 3 from proposition 3, I match Chilean exporters to Colombian importers. Colombian data is available from 2008 to 2016. Then, I ran the following regression:

$$I(CIA_{fpt} = 1) = \beta_0 Y_{ft}^{CHL} + \beta_1 Y_{ft}^{CHL} \times Y_{ft}^{COL} + \gamma_{it} + \varepsilon_{fpt}, \tag{1.23}$$

where γ_{it} are industry $\times$ year fixed effects. Table 1.5 shows the results of the regression, as it can be seen when a transaction is between a small exporter and a large importer, the transaction is less likely to be under CIA. As for size, in column (1), for Chilean firms, I used the same classification of size according to the tax agency, in columns (2) and (3) I computed the quartiles according to employment and equity. As for Colombian firms, I computed size using total imports for a given firm as a proxy for size, and I computed the corresponding quartiles for that measure.

Table 1.5: Matched CHL-COL data. Sample 2008-2016. CIA v/s OA

	Y_{ft}^{CHL} =Sales bracket	Y_{ft}^{CHL} =Employment	Y_{ft}^{CHL} =Equity
Micro_{CHL}	0.026 (0.018)	0.044*** (0.008)	0.046*** (0.007)
Small_{CHL}	0.084*** (0.022)	0.015 (0.011)	0.017* (0.009)
Medium_{CHL}	0.041*** (0.009)	0.011 (0.009)	0.022** (0.011)
Large_{COL}	-0.034*** (0.005)	-0.027*** (0.01)	-0.024*** (0.007)
$\text{Micro}_{CHL} \times \text{Large}_{COL}$	-0.104* (0.058)	-0.022* (0.012)	-0.029** (0.012)
$\text{Small}_{CHL} \times \text{Large}_{COL}$	-0.103*** (0.031)	-0.013 (0.016)	0.007 (0.014)
$\text{Medium}_{CHL} \times \text{Large}_{COL}$	-0.017 (0.019)	-0.009 (0.013)	-0.025* (0.013)
Observations	273081	266613	253221
R^2	0.182	0.1769	0.1716

Robust standard errors are clustered at exporter-importer level
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.010$

Finally, using the same matched exporter-importer data, we can draw the empirical version of Figure 1.5 that described the contract choice as a function of sizes. Figure 1.9 describes the empirical distribution of transactions as a function of the size of Colombian importer and Chilean exporter.

For ease of exposition, I additionally plotted the centroid for each contract. It can be seen that CIA transactions are on average related to small firms as opposed to OA transactions. I additionally plotted a separating line[9] between the two contracts. This curve, in some sense, is the empirical counterpart of the theoretical decision curve showed in figure 1.5.

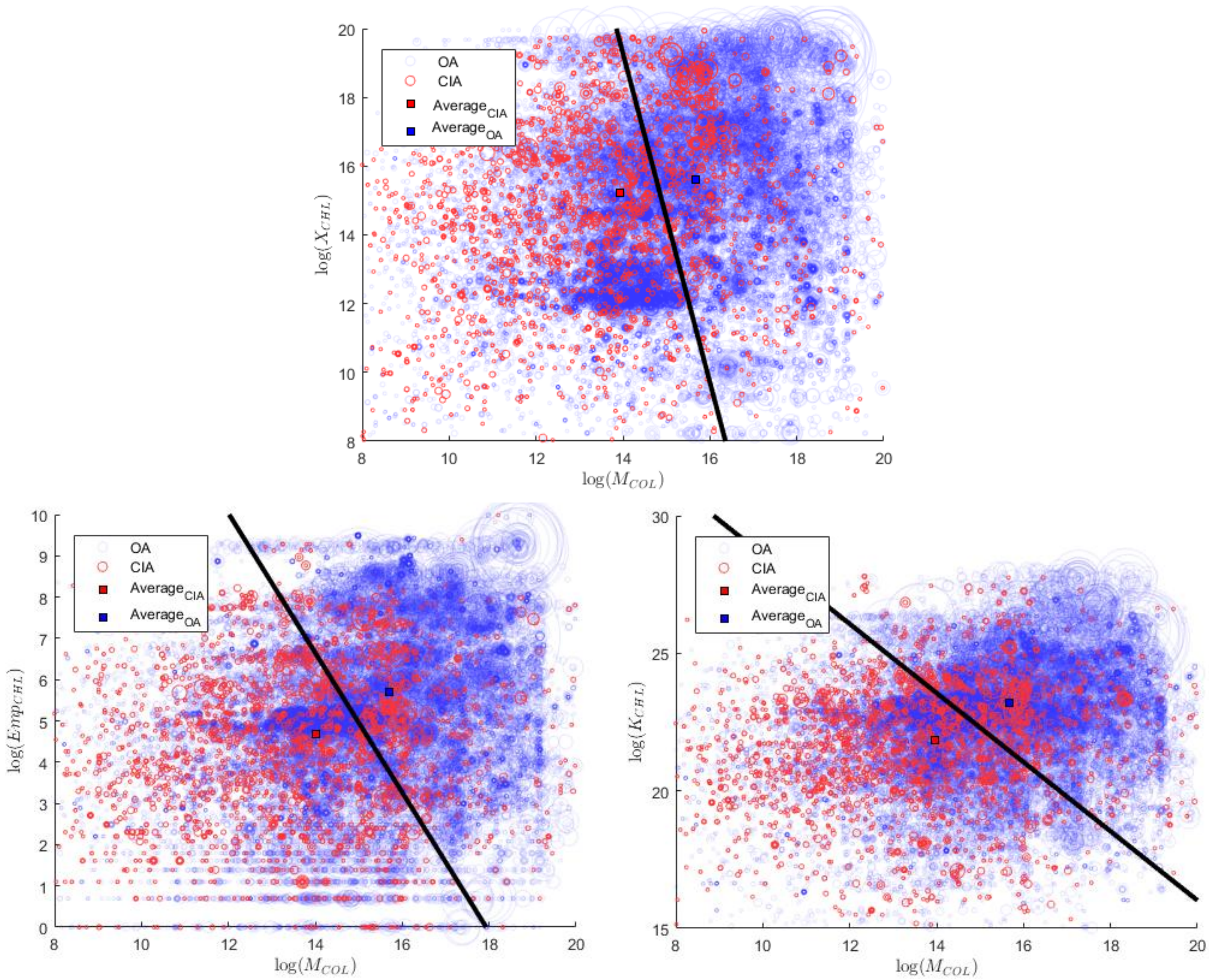
1.5.2 Transfers, prices and payment contract

To test Proposition 4, I will estimate the following equation

$$Y_{fdpt} = \beta I(CIA_{fdpt} = 1) + \mu_{fdpt} + \varepsilon_{fdpt} \tag{1.24}$$

[9]The separating plane is just a line that passes through the midpoint of the segment that connects both centroids and is perpendicular to said segment. Since very few transactions are CIA in the sample (5% of the sample) alternative techniques of classification curves did not work. This classification line does a fine job since 60% of OA transactions are above the line and 60% of CIA transactions are below

Figure 1.9: Empirical distribution of transactions for different measures of size



Note: Each bubble is a transaction of particular good in a given year between an exporter and importer of given size. The size of a bubble is related to the amount of transactions in a year for the Exp-Imp match and product.

for exports only, where Y_{fdpt} will be log of FOB transfer and log of price for a given firm f, selling to destination d a product p at year t, μ_{fdpt} are fixed effects at firm×destination×product×year in order to control for demand shifters and marginal cost changes.

Table 1.6: Prices under CIA - Exports

	$\log(q)$	$\log(T_{FOB})$	$\log(T_{FOB})$	$\log(p)$	$\log(p)$
CIA	-0.572***	-0.550***	-0.0517***	0.0146	-0.0517***
	(0.0495)	(0.0468)	(0.00875)	(0.00915)	(0.00875)
$\log(q)$			0.884***		-0.116***
			(0.00929)		(0.00929)
Observations	609312	613865	609308	609308	609308
R^2	0.817	0.717	0.969	0.932	0.941

Robust standard errors clustered at firm and at country level
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.010$

As table 6 shows, transfers and prices are lower under CIA. On average, for the same quantity, the price/transfer is almost 5% lower with prepayment. Unfortunately, I do not have the period for the trade credit, but according to standard practices, the post-payment can be done between 30 and 120 days after arrival. This would imply an annual interest rate between 15 to 60%. Similar results can be found running a specification for imports, as table 7 below shows.

Table 1.7: Prices under CIA - Imports

	$\log(T_{FOB})$	$\log(T_{FOB})$	$\log(p)$	$\log(p)$
CIA	-0.265***	-0.0626**	0.006	-0.0626***
	(0.0321)	(0.0071)	(0.0233)	(0.0071)
$\log(q)$		0.747***		-0.253***
		(0.0178)		(0.0178)
Observations	4941301	4941297	4941297	4941297
R^2	0.696	0.916	0.903	0.926

Robust standard errors clustered at firm and at country level
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.010$

1.6 Dynamics

So far, the model is static. A simple way to extend this model to include dynamics is to introduce learning. Papers like Araujo and Ornelas (2007), Antràs and Foley (2015) include learning through a Bayesian updating process regarding the quality of institutions or importer's type. Given the structure of the model and the endogenous default probability, I cannot introduce learning in the same fashion. To make progress, I will assume that exporters do not know the distribution of the importer's cost shock, in particular, producers do not know the variance of the distribution, but they still know that the mean is zero.

The model and timing are exactly as before but now the tenure of the Exp-Imp relationship will play a role. As explained, the producer (and possibly the foreign bank) does not know the variance of the distribution G, but she has a prior. Since defaults are public, after a successful interaction between exporter and importer (either under CIA or OA), the exporter learns the value of the shock λ^* and updates her prior. I will assume that if a firm defaults on a credit or trade credit, the firm exits and is replaced by another one with no history. Finally, after payments are realized, each firm has a probability δ of exiting the market. This will not play a role in this partial equilibrium framework but I assume it to maintain stationarity.

1.6.1 Learning

For simplicity, I will assume that $\lambda^* \sim N(0, \sigma_F^2)$, where σ_F^2 is unknown to the exporter. Additionally, let me assume that the exporter has a prior distribution Gamma with shape α and scale β (i.e. $Gamma(\alpha, \beta)$) for σ_F^2. Under these parametric assumptions, the posterior mean of σ_F^2 for a Exp-Imp relationship with tenure t is given by:

$$\sigma_t^2 = \sigma_0^2 \gamma_t + \hat{\sigma}_t^2 (1 - \gamma_t), \tag{1.25}$$

where $\sigma_0^2 = \frac{\beta}{\alpha}$ is the prior mean, $\gamma_t = \frac{2\alpha}{2\alpha+t}$ is the weight of the prior and $\hat{\sigma}_t^2 = \frac{\sum_{n=0}^{t}(\lambda_t^*)^2}{n}$ is the sample variance. Note that for a given, σ_0^2, α governs how fast the exporter updates her prior or equivalently how informative is the new information. Finally, as the tenure of the relationship increases, $\sigma_t^2 \to \sigma_F^2$, so depending on the prior, learning will imply that variance increases or decreases with tenure.

The following proposition will help me to describe the dynamics of the model under learning.

Proposition 5. *If $\rho^* > \rho$. For given sizes N and N^*:*

1. *If the variance of G increases, it is less likely that a transaction is under OA.*

2. *Similarly, if the variance of F increases, it is less likely that a transaction is under OA.*

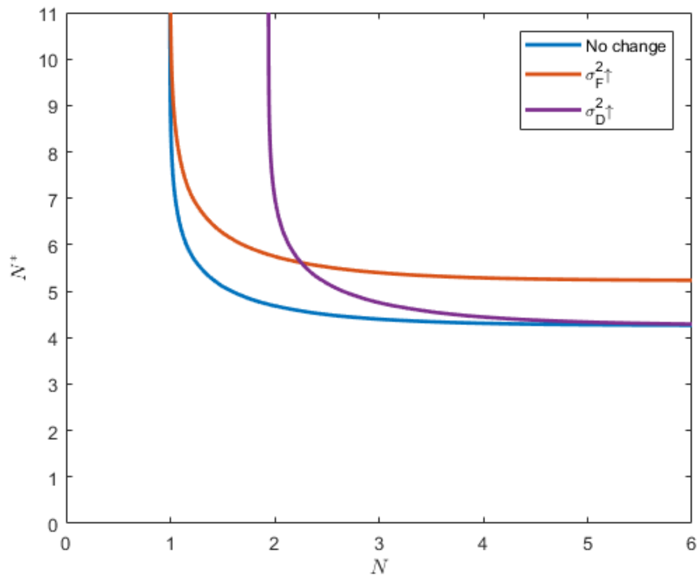
Proof. Without loss of generality, I will assume that F and G are Normal distributions with mean zero. Then $F(x) = \Phi\left(\frac{x}{\sigma}\right)$, where Φ is the c.d.f. of $N(0,1)$. G can also be expressed as a function of Φ. From equation (21) is easy to see that when the variance of F or G increases, $\theta(N, N^*)$ decreases, which means the decision boundary shifts down/left depending on which variance is changing. Then transactions that previously where done under OA, now potentially can be conducted under CIA. ■

This result is intuitive since, for a given size N and N^*, an increase in the volatility of the cost shock makes it more likely to default, thus the likelihood of OA must decrease. Figure 1.10 shows the changes in the decision border when variance of the foreign shock σ_F^2 and domestic shock σ_D^2 increases.

1.6.2 Contract choice over time

Using the previous proposition and results, I can describe how learning will affect the contract choice over time.

Figure 1.10: Changes in policy



Corollary 1. *Let* $\pi(N, N^*) \geq F$, $\rho^* > \rho$

1. *If prior* σ_0^2 *is greater than the true parameter* σ_F^2*. Likelihood of OA transaction increases with the tenure of the relationship.*

2. *If prior* σ_0^2 *is less than the true parameter* σ_F^2*. Likelihood of OA transaction decreases with the tenure of the relationship.*

This result does not rely on the assumption of symmetric learning, meaning foreign bank and exporter learn as tenure increases, or asymmetric learning, only the producer learns about the variance. Intuitively, this is saying that, as agents learn over time, all transactions will be only under CIA or exclusively under OA. As Antràs and Foley (2015) have pointed out, data seems to favor that the likelihood of a transaction being under OA increases over time. This will be one of the additional predictions that I will test.

Corollary 2. *If* $\pi(N, N^*) \geq F$, $\rho^* > \rho$ *and* $\sigma_0^2 > \sigma_F^2$ *then*

1. *Transactions under CIA are less likely as the tenure of relationship increases.*

2. *Prices under OA decrease over time.*

3. *Quantities and sales under OA increase over time.*

The last two parts are a natural outcome since, as default probability decreases, surplus increases, thus quantities increase therefore prices decrease. Finally, the last two statements may be also be true under CIA, but only if the learning is symmetric, since in that case, foreign bank will also lend more at a lower interest rate (default probability decreases), but if the learning is asymmetric, prices and quantities under CIA will remain constant with tenure.

1.6.3 Empirical test on Dynamics

To test the predictions from Corollary 2, I will use the identification strategy for dynamics proposed by Piveteau (2019). He proposes the following model:

$$Y_{fdpt} = \sum_{\tau=1}^{T} \beta_\tau I(\text{tenure}_{fdpt} = \tau) + \mu_{dpt} + \varepsilon_{fdt} \tag{1.26}$$

where tenure_{fdpt} is the amount consecutive years firm f has been selling product p to destination d at year t,[10] μ_{dpt} is a destination$\times$ product$\times$year fixed effect. For each part of the corollary, Y_{fdpt} will be either an indicator function if transaction was paid under CIA, log prices, log quantities and log sales when transactions were under OA. Thus, for the first prediction, I will estimate

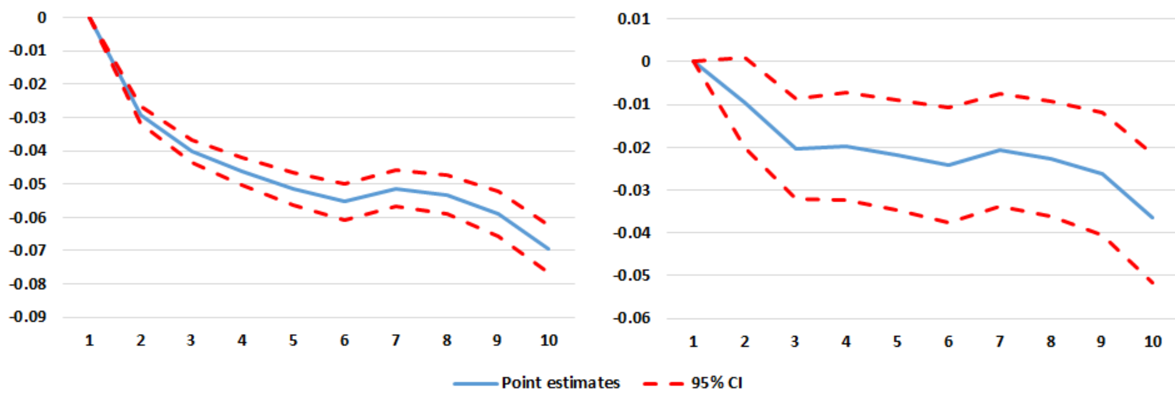
$$I(CIA_{fdpt} = 1) = \sum_{\tau=1}^{T} \beta_\tau I(\text{tenure}_{fdpt} = \tau) + \mu_{dpt} + \varepsilon_{fdt} \tag{1.27}$$

Figure 1.11 shows β_τ, in particular, left panel show the plot for all the sample. As Piveteau (2019) stresses out, in order to correct for selection bias (relationships than endure are better firms with better products), I estimate the same regression but restricting the sample to relationships that lasted more than 8 years, these results are shown on the right panel.

[10] Since in my main dataset I do not see the pair Exp-Imp, I proxy a relationship as a firm selling the same product to the same country.

In any case, it can be seen that probability of CIA decreases over time.

Figure 1.11: Likelihood of CIA over time

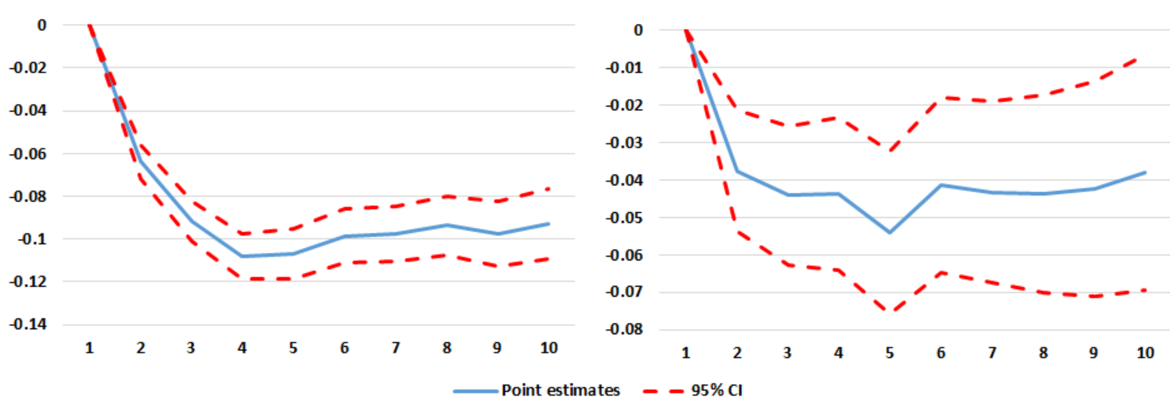


For the second prediction, I will estimate

$$\log p_{fdpt}^{OA} = \sum_{\tau=1}^{T} \beta_\tau I(\text{tenure}_{fdpt} = \tau) + \mu_{dpt} + \varepsilon_{fdpt} \tag{1.28}$$

where p_{fdpt}^{OA} will be the unit value, but only when the transaction was paid under OA, the rest of the model is a before. Figure 1.12 shows prices over time. As predicted by the theory but opposed to Piveteau (2019) I find that prices, in fact, decrease[11] Finally, I will

Figure 1.12: Prices over time



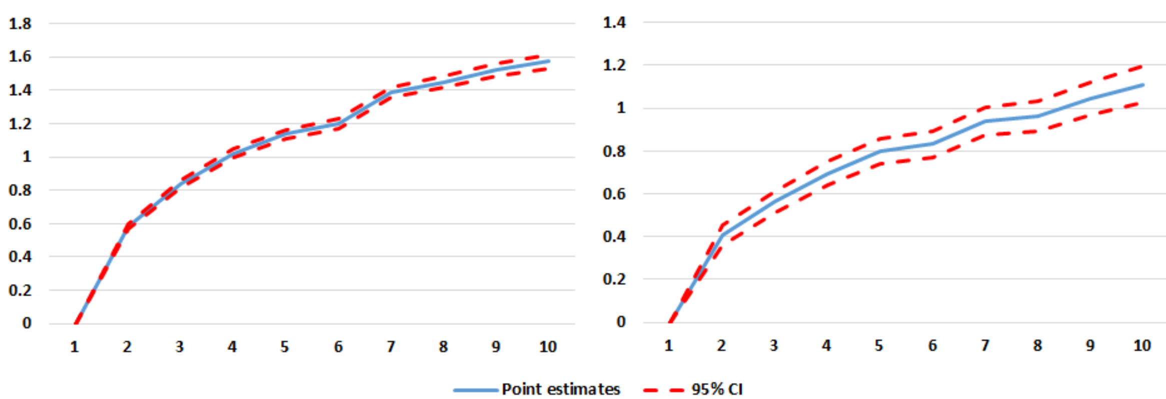
[11]Since more than 80% of the transactions are under OA, this relationship will be true even if I run the regression over the whole sample.

estimate the following equation

$$\log q^{OA}_{fdpt} = \sum_{\tau=1}^{T} \beta_\tau I(\text{tenure}_{fdpt} = \tau) + \mu_{dpt} + \varepsilon_{fdpt} \tag{1.29}$$

As for the remainder of the predictions, I will only show the results for quantities, since for sales the results and conclusions are identical. Figure 1.13 shows how quantities increase with tenure.

Figure 1.13: Quantities over time



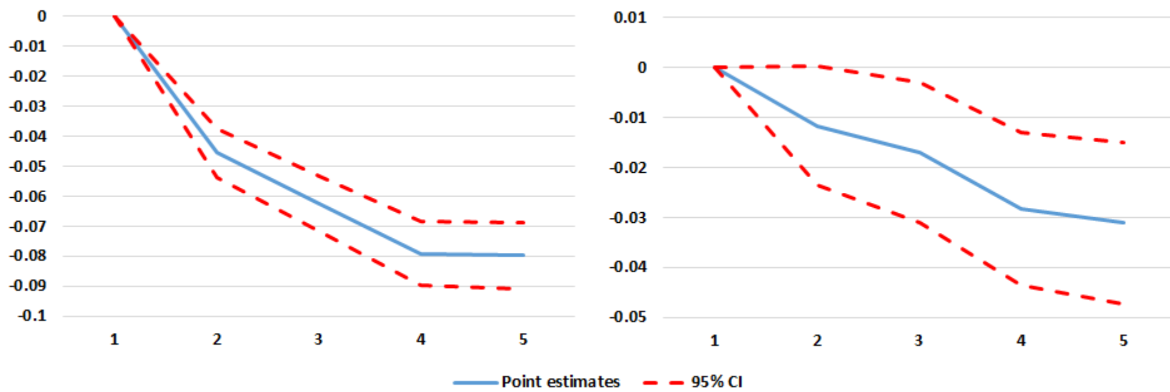
In all the cases, the data supports the predictions of the model regarding dynamics. One of the main issues in these regressions is that I am using a proxy for relationships. To tackle this problem, I used matched Chile-Colombia data where I can compute actual tenure of the relationship between a Chilean Exporter and a Colombian importer and estimate a similar equation

$$Y_{fdpt} = \sum_{\tau=1}^{T} \beta_\tau I(\text{tenure}_{fpt} = \tau) + \mu_{pt} + \varepsilon_{ft}, \tag{1.30}$$

the downside of the matched data is that I can only match the 2008-2016 period, so the maximum tenure I can have is 9 years and I observed their relationship starting in 2008 whereas it could have started earlier. I show the results for the likelihood of CIA transactions, and I leave the results for price and quantities in the Appendix.

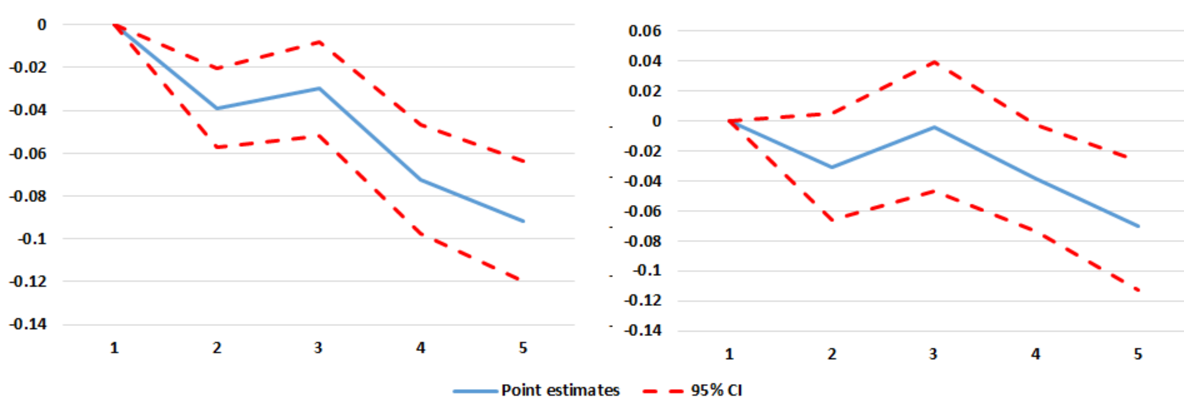
Figure 1.14 shows similar results than before. Due to the short period of time that I have, in the right panel, I show the results when I restrict the sample to relationships that lasted

Figure 1.14: Likelihood of CIA over time CHL-COL data



more than 4 years. As shown in the Appendix, quantities also behave similarly compared to the full sample, whereas the point estimates for prices are similar but in many cases, these are not significant. Finally, to better measure tenure, I estimate the same equation but for exporters that were born after 2006, then I am better measuring the true tenure. As Figure 17 shows results do not change qualitatively.

Figure 1.15: Likelihood of CIA over time CHL-COL data



Note: Sample restricted to exporters that were born after 2006

1.7 Conclusion

The international trade finance literature has focused on the country-specific factor that affects the trade credit decision for exporting/importing firms, while several surveys to exporters indicate that the risk of default is an important deterrent to export. In this paper, I introduce a simple trade finance model with firm heterogeneity and proceed to test the implications of the model on the data.

In particular, under reasonable assumptions, the model implies that large firms give (and receive) more trade credit compared to small firms. The model also has implications for the exporter-importer match and their corresponding sizes. Using Chilean transaction-level data combined with firm-level data I test and confirm these implications using several measures of size, productivity, and exporter/importer data. In particular, small exporters are 20-30% more likely to sell through prepayment when compared to large firms. Similarly, small importers are 50-60% more likely to buy prepaying compared to large importers.

Extending the model to include dynamics, I can additionally test further implications of the model. In particular, under simple assumptions that previous literature seems to favor, the model predicts that transactions under CIA are less likely as the tenure of the relationship increases, prices (quantities and sales) decrease (increase) with the tenure of the relationship. These predictions are also confirmed in the data using the main dataset and also a smaller one with matched exporter-importer.

This paper contributes to a new dimension not yet analyzed in the literature of trade credit, namely firm-characteristics that shape the trade finance choice. Additionally, notice that the financial friction due to the payment contract behaves as if it were an additional fixed cost of exporting (interest rate payment).

From the policy-making perspective, these frictions could be problematic, since small exporter matched with a large firm like Walmart will export using trade credit, which puts an extra burden over the exporter, that in presence of additional shocks, that I abstracted from, can have further implications like bankruptcy. A more sophisticated dynamic model with additional shocks is necessary to understand what are the potential effects of this friction in additional dimensions, like entry/exit and firm default risk.

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1.A Size and CIA

To make comparable, for each measure I compute 13 quantiles and plot the average share CIA in each quantile.

Figure 1.A.1: CIA Share - Total Exp/Imp

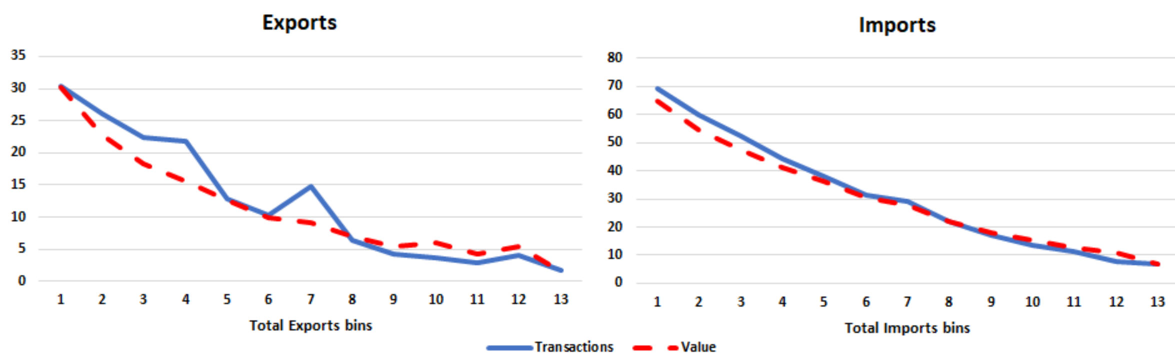
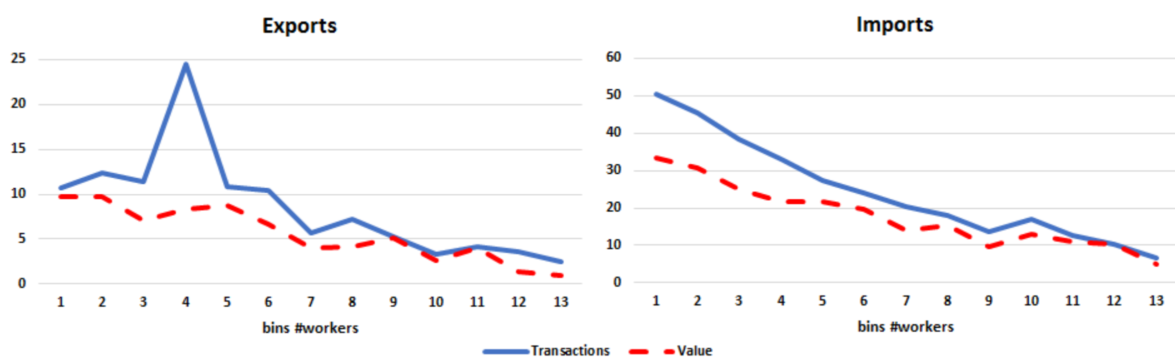


Figure 1.A.2: CIA Share - Number of workers



As it can be seen, CIA share decreases with measures of size or related to size (productivity, age).

Figure 1.A.3: CIA Share - Exports/Workers

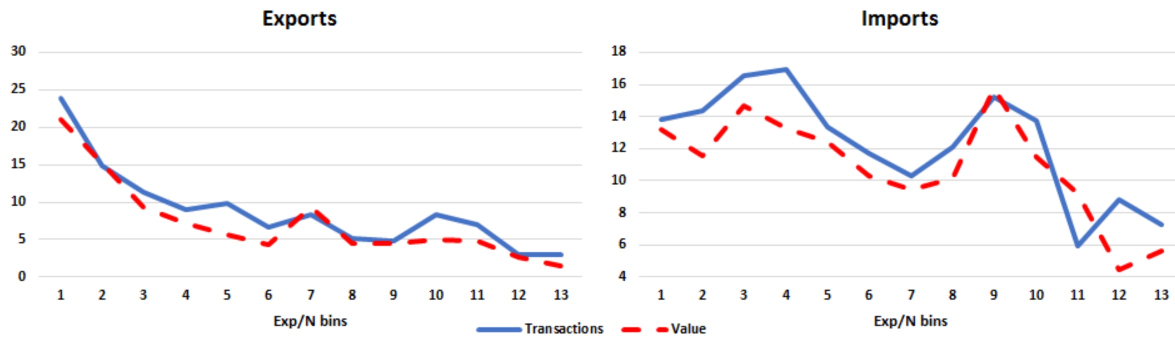
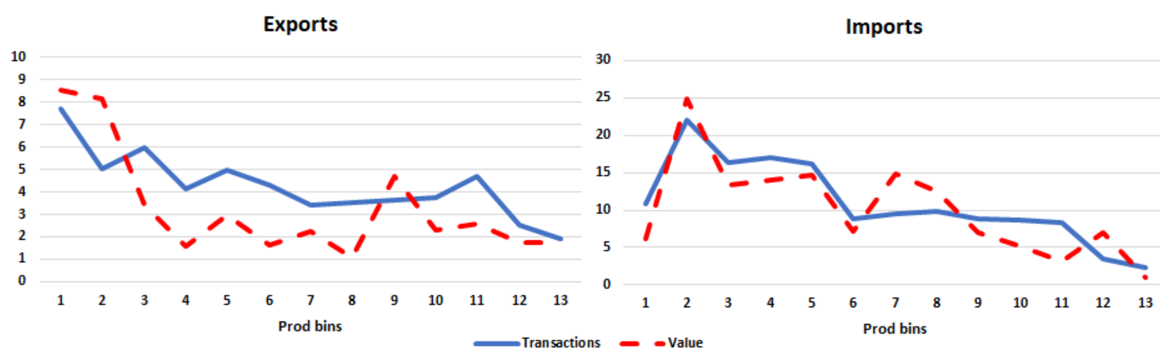
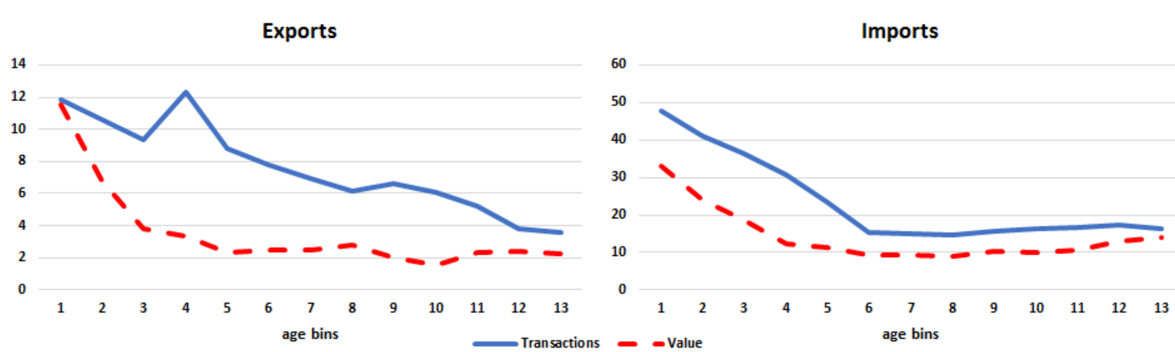


Figure 1.A.4: CIA Share - Productivity



Note: Computed using Levinsohn and Petrin (2003) for a subset of manufacturing firms between 2003-2007

Figure 1.A.5: CIA Share - Age



1.B Dynamics

Figure 1.B.6: Prices over time CHL-COL data

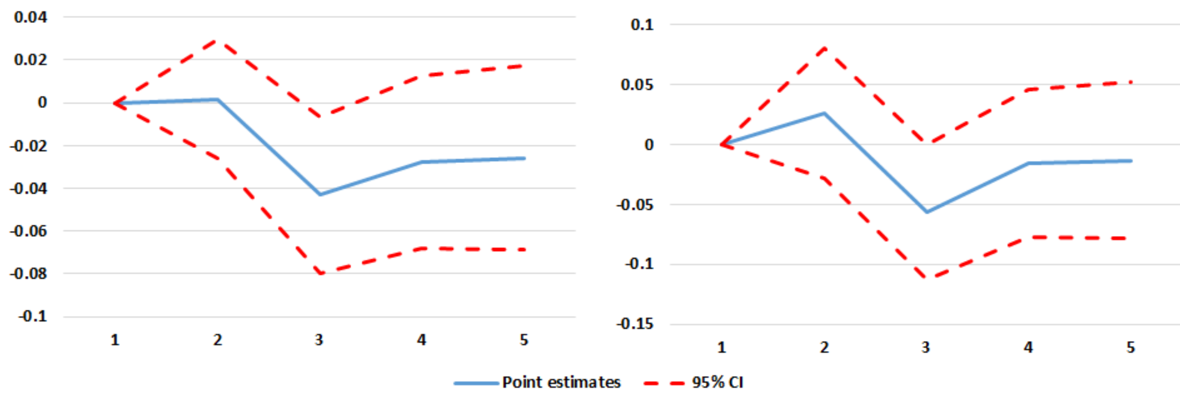


Figure 1.B.7: Quantities over time CHL-COL data

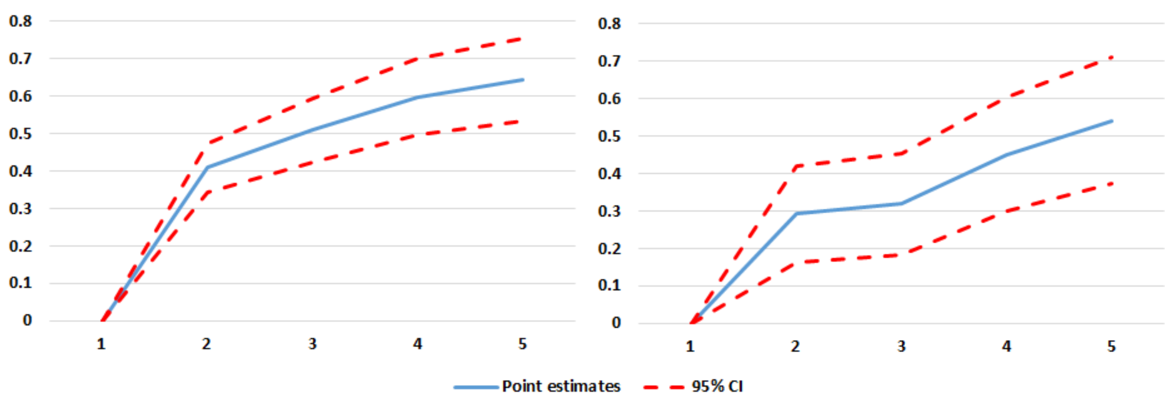


Figure 1.B.8: Prices over time CHL-COL data. Exp born after 2006

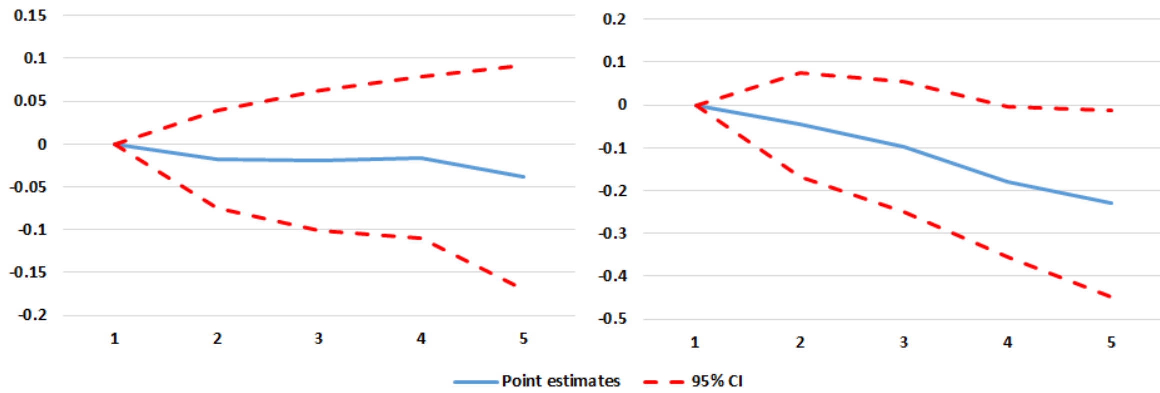
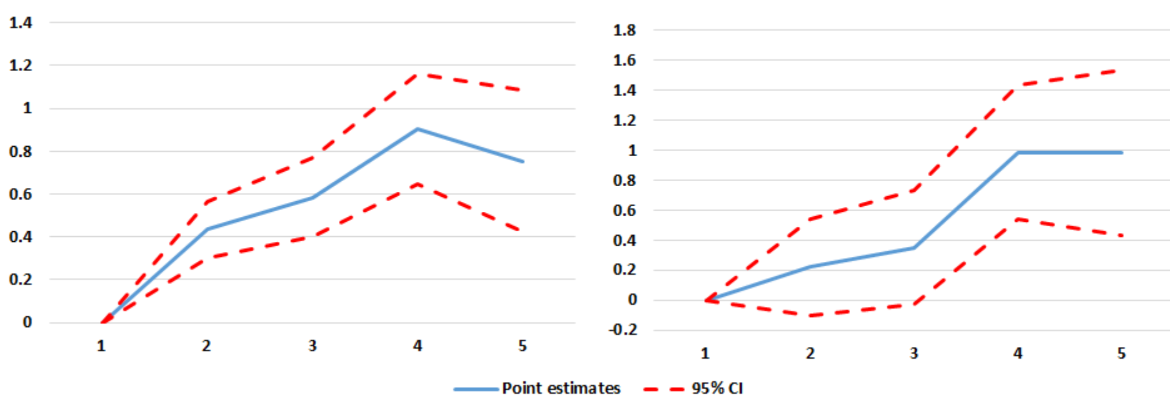


Figure 1.B.9: Quantities over time CHL-COL data. Exp born after 2006



Chapter 2

Trade Credit and Markups

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Santiago Andrés Justel, UCLA

Trade credit is the most important form of short-term finance for U.S. firms. In 2017, non-financial firms had about $3 trillion in trade credit outstanding equaling 20 percent of U.S. GDP. Why do sellers lend to their buyers in the presence of a well-developed financial sector? This paper proposes an explanation for the puzzling dominance of trade credit: When sellers charge markups over production costs and financial intermediation is costly, then buyer-seller pairs can save on their overall financing costs by utilizing trade credit. We derive a model of trade credit and markups that captures this mechanism. In the model, the larger is the markup and the larger is the difference between the borrowing and the deposit rate, the more attractive is trade credit. The model also implies that trade credit use increases with repeated interactions and that this effect is stronger for complex products. Using Chilean data at the firm-level to estimate markups and at the trade-transaction level to analyze payment choices, we find strong support for the model.

2.1 Introduction

Trade credit is the most important form of short-term finance for U.S. firms. In 2017, non-financial firms had about $3 trillion in trade credit outstanding equaling 20 percent of U.S. GDP.[1] Why do sellers lend to their buyers in the presence of a well-developed financial sector? While several theories about trade credit have been proposed, the popularity of trade credit remains a puzzle.[2] This paper proposes an explanation for why trade credit is so popular: When sellers charge markups over production costs and financial intermediation is costly, then buyer-seller pairs can save on their overall financing costs by utilizing trade credit.

A buyer can pay for a purchase in two ways: through cash-in-advance, where the buyer pays the full price of the goods before delivery, and on an open account where the buyer has some time after delivery to pay for the goods and thus implicitly receives a trade credit from the seller.[3] Under cash-in-advance, the buyer needs to pre-pay the full amount to the seller which requires liquidity equal to the full invoice. In contrast, extending trade credit is cheaper in liquidity terms, as the seller only needs to cover its production costs in advance which may be substantially lower than the sales price if there is a markup. If financial intermediation is costly and a firm pays more to a bank for borrowing funds than it receives for depositing them, then this difference in liquidity needs between cash-in-advance and trade credit affects profits.

The larger is the markup and the larger the difference between the borrowing and the

[1] See also Figure 2.A.1 in Appendix 2.A that shows the development of trade credit and markups over time in the United States.

[2] See in particular Ellingsen, Jacobson, and E. L. v. Schedvin (2016) who argue that based on their evidence there is a need for a "new theory of short term finance".

[3] In international trade, additional financing options are available that are called letter of credit and documentary collections. For these alternatives, banks act as intermediaries to reduce the risk involved in a transaction. See Niepmann and Schmidt-Eisenlohr (2017a) for details. They find that letters of credit cover about 13 percent and documentary collections about 2 percent of world trade. Both payment forms do not play a role for domestic transactions. There may also be a partial advance-payment, on which data is even more limited. In our data from Chile two-part contracts (partial cash-in-advance) represent only 0.2% of transactions. Similarly, Antràs and Foley (2015) report that the firm they study does not rely on two-part contracts.

deposit rate, the more attractive is trade credit. All else equal, trade credit is preferred over cash-in-advance if there is a positive markup and a positive interest rate spread. As the world typically features positive markups and positive interest rate spreads, the theory thus provides a clear rationale for the dominance of trade credit in firm-to-firm transactions.

We test the model using two rich panel datasets of Chilean firms. First, we construct markup estimates at the firm-product level using detailed production data on inputs and outputs of Chilean plants following the method developed by De Loecker, Goldberg, Khandelwal, and Pavcnik (2016). We then combine these markup estimates with transaction-level trade data, which contains detailed information on the payment choice to test the predictions of the model. We find that trade credit use increases with markups and that this effects is larger the bigger the difference between the buyer's borrowing rate and the seller's deposit rate.[4] In line with the model's prediction, the effect of the markup also increases in the destination country's rule of law. In addition, the results are robust to alternative measures of markups, and to the inclusions of a large set of fixed effect and control variables. Taken together, these results provide strong support for the main mechanism of the model.

Our results are very similar when we focus on the subset of firms with low participation in export markets. For these firms, markups mostly reflects the firm's pricing decisions in the domestic market. Hence, any endogenous response of the markup to the trade credit choice in a particular destination gets mitigated when fixing markups at their initial value for each seller-product or computing markups at the firm-level. Jointly, these results suggest that, even though firms charge higher markups on transactions involving trade credit, the resulting bias should be relatively modest.

We also develop a dynamic version of the model, showing that when firms learn about their trading partners, trade credit becomes more attractive over time. The key intuition is that learning reduces the relevance of enforcement frictions. As trade credit has a financing

[4] Petersen and R. G. Rajan (1997) provided evidence that firms with larger gross profit margins over costs extend more trade credit. As gross profit margins can arguably be seen as a rough proxy for markups, their findings are thus consistent with the model presented here.

cost advantage over cash-in-advance, learning thus tilts the payment choice towards trade credit as enforcement frictions becomes less central. We show that this rationale also implies that the effects of learning are stronger for more complex products.[5] In the empirical section, we provide evidence that strongly supports these dynamic predictions.

The model also has implications for the pricing of transactions between importers and exporters. Schmidt-Eisenlohr (2013) and Antràs and Foley (2015) also derived price predictions in a payment terms model. We extend the analysis, showing that there is an unambiguous ordering of prices that is independent of the distribution of bargaining power. Specifically, a buyer has to pay a higher price to the seller when buying with trade credit than when paying in advance. This difference should increase in the borrowing rate of the seller and decrease in the level of contract enforcement in the buyer's country. We find that buyers pay a higher price when receiving trade credit and that the price difference decreases in the destination country's rule of law and increases in source country's borrowing rate.

The paper contributes to the large and growing literature on trade credit.[6] Several theoretical reasons have been given for the importance of trade credit. Schwartz (1974) and Ferris (1981) develop models where trade credit arises from a transaction motive, by separating the exchange of goods from the exchange of money, which may simplify cash management and allow for risk-sharing. Brennan, Maksimovics, and Zechner (1988) show that trade credit can be used to price discriminate when cash buyers have higher reservation values than credit buyers.[7] J. K. Smith (1987) and Biais and Gollier (1997) show that firms may extend trade credit because they have an informational advantage relative to banks. In Burkart and Ellingsen (2004) sellers extend trade credit because this type of credit is

[5]Giannetti, Burkart, and Ellingsen (2011) also look at the relationship between product type and trade credit and find that for the case of domestic firm-to-firm transactions, trade credit is higher in differentiated products.

[6]Petersen and R. G. Rajan (1997) provide an early overview of the main theories for the existence and prevalence of trade credit and present empirical evidence.

[7]Petersen and R. G. Rajan (1997) argue that this channel should be stronger when gross profit margins are higher as sellers have a stronger incentive to sell one more unit at a discount when their marginal profit is higher. For this reason, price discrimination may also give rise to a positive correlation between markups and trade credit use. On price discrimination through trade credit, see also Schwartz and Whitcomb (1979) and Mian and C. W. Smith (1992).

"in-kind" and is thus harder to divert than cash. Our model is closely related to these earlier papers in that parts of the spreads between borrowing rates and deposit rates that banks charge are likely attributable to the monitoring and enforcement frictions emphasized there. However, bank spreads are also due to factors like regulation, capital requirements and general overhead costs. The key message of our model is that firm pairs should for this reason minimize their reliance on the financial sector for financing their transactions, and are able to do so through trade credit if sellers charge positive markups over marginal costs.

Wilner (2000) builds a model that studies the interaction of trade credit provision and long-term relationships, where firms are willing to give more concessions when there is a dependency. In a related paper, Cunat (2007) shows that trade credit may work better in buyer-supplier relationships as the supplier can threaten to cut supplies if trade credit is not repaid. Emery (1984) argues for "a pure financial explanation of trade credit".[8] In his model, sellers have to hold liquidity for a precautionary motive in a world characterized by imperfect financial markets. As trade credit can be factored, lending to a buyer only marginally reduces liquidity while it raises profits by exploiting the difference between the buyer's borrowing rate and the sellers deposit rate. While his explanation of trade credit is also based on the difference between the borrowing and the lending rate, the underlying mechanism is quite different. In his paper, sellers need to have a liquidity holding motive to extend trade credit. In the model presented here, in contrast, trade credit is desirable even in the absence of any liquidity holdings. With positive markups, a seller can be willing to borrow from a bank to extend trade credit to the buyer as this saves on overall financing costs.

Closest to our paper, Daripa and J. Nilsen (2011) develop a model of inventory holding, demand uncertainty and trade credit. In their model, an upstream firm supplies trade credit to a downstream buyer to alleviate an externality that arises from inventory holding costs. If the upstream seller's markup over production costs is larger than the downstream buyer's

[8] See also Ahn (2014), who also studies this mechanism and tests it with Chilean and Colombian data.

markup over the intermediate good's price, then the upstream seller wants to subsidize the downstream buyer's inventory holdings. It does so through a lower price when it has higher financing costs than the buyer and through trade credit when it has lower financing costs than the buyer. In the model, trade credit is thus preferable if the upstream margin is larger than the downstream margin and if, at the same time, the upstream firm faces lower financing costs. While our model is also based on markups and financing costs, there are important differences that give rise to a much more general preference for trade credit. Most importantly, we introduce the realistic feature of a margin between the borrowing rate that banks charge and the deposit rate that savers receive. As we show below, in the presence of a positive financing friction, trade credit dominates cash-in-advance as long as the seller charges a positive markup. In contrast to the model in Daripa and J. Nilsen (2011), the preference for trade credit does not depend on the buyer's markup, the relative markup between the buyer and the seller or a difference in financing costs between the two firms.

Our paper also relates to a recent literature that studies the role of trade credit as a form of limiting competition. Peura, Yang, and Laic (2017) develop a model with Bertrand competition, and potential liquidity shocks, and show that trade credit exposes firms to higher financing costs, reducing their incentives to undercut prices. Giannetti, Serrano-Velarde, and Tarantino (2018) argue that suppliers extend trade credit to financially-unconstrained large firms as a form to transfer surplus to these firms without cannibalizing sales to small buyers. Chod, Lyandres, and Yang (2019) develop a model where trade credit allows buyers to use the additional liquidity to increase their purchases of inputs. Thus, in this model sellers are more willing to offer trade credit when competition is lower, because then they internalize more of the benefits related to trade credit provision. Assuming that lower competition is reflected in a higher markup, these papers would also generate a positive correlation between trade credit and markups as our paper. However, notice that our mechanism is quite different. In our model, trade credit arises as a way of reducing financing costs, while in their case trade credit is chosen strategically either, as a form of limiting competition or for reaping benefits from the supply chains.

Our paper also adds to the empirical evidence on trade credit. Most papers have focused on domestic data. Ng, J. K. Smith, and R. L. Smith (1999), for example, exploit detailed data to analyze the terms of trade credit contracts. Giannetti, Burkart, and Ellingsen (2011) and Klapper, Laeven, and R. Rajan (2012) further tested theories of trade credit with contract data.[9] Recently, Ellingsen, Jacobson, and E. L. v. Schedvin (2016) study detailed trade credit data from Sweden. Consistent with earlier papers, they find that when a firm's financial position improves, it has less accounts payable (that is trade credit that needs to be repaid) on its balance sheet. The correlation between trade credit volume and financial health is, however, not due to shorter trade credit terms but instead due to less purchases by the firm from its suppliers. This finding is inconsistent with the standard view in the literature that trade credit is less desirable to firms than bank credit.

There is a small and growing literature on international trade finance, typically studying three payment forms, open account, cash-in-advance and letters of credit. While open account corresponds to providing trade credit, letters of credit are a financing form that is almost exclusively used international transactions due to the larger risks involved in cross-border trade. Schmidt-Eisenlohr (2013), Antràs and Foley (2015) and Niepmann and Schmidt-Eisenlohr (2017a) study how payment choices depend on financing cost and limited contract enforcement. Hoefele, Schmidt-Eisenlohr, and Yu (2016) extend that analysis and look at the role of product complexity. Demir and Javorcik (2018) employ Turkish export data, showing that the removal of the Multi-Fiber Arrangement led to more trade credit provision by Turkish exporters.[10]

There is substantial evidence on the macro-economic importance of trade credit. Fisman and Love (2003) show that trade credit can alleviate concerns of limited contract enforcement

[9]See also Barrot (2016) on trade credit and entry in the trucking industry and Murfin and Njoroge (2014) on the opportunity cost of extending trade credit to large firms.

[10]See also Ahn (2010), Olsen (2010) and Niepmann and Schmidt-Eisenlohr (2017a). For papers studying the broader relationship of financial constraints and trade, see among others Amiti and Weinstein (2011), Chor and Manova (2012), Manova (2013), Paravisini, Rappoport, Schnabl, and Wolfenzon (2014) and Niepmann and Schmidt-Eisenlohr (2017b).

and thereby increase growth, while J. H. Nilsen (2002) explores the relationship between the bank lending channel and trade credit. Love, Preve, and Sarria-Allende (2007) study trade credit use in emerging economies in the wake of financial crises. Jacobson and E. v. Schedvin (2015) look at trade credit propagation and its effects on corporate failure.

To summarize, this paper contributes to the literature by proposing an explanation for the dominance of trade credit based on markups and the costs of financial intermediation and by providing evidence for this theory exploiting Chilean international trade data and domestic production data. It also generalizes the standard trade finance model, allowing for arbitrary bargaining weights between buyers and sellers and providing unambiguous predictions on relative prices between trade credit and cash in advance. Finally, it shows that the use of trade credit increases in the number of interactions between buyers and sellers and that this effect is stronger for more complex products, rationalizing this finding with a simple model of learning.

The remainder of the paper is organized as follows. Section 2 presents a theoretical framework for trade credit use and derives the main testable predictions. Section 3 discusses the empirical specifications, and presents the methodology for deriving firm-product markups. Section 4 describes our dataset. Section 5 presents the empirical results, and quantifies the general importance of trade credit. Finally, section 6 discusses implications of our study and routes for future research.

2.2 A model of trade credit and markups

In this section, we extend the model in Schmidt-Eisenlohr (2013) and show how a positive markup and a financial intermediation cost lead to a natural preference for trade credit. In the model there are three key elements. First, there is a time delay between the production of the goods by the seller and the sale of the goods by the buyer. Second, financing is costly. To pay for goods or production costs, firms have to borrow funds from the financial sector.

Firms can also deposit surplus liquidity as deposits with the banking sector. Importantly, because of regulation, monitoring and general overhead costs, banks charge a higher interest rate when lending funds to firms than the interest rates they pay to depositors.[11] Third, there is imperfect contract enforcement. When a buyer or seller do not fulfill their contractual obligations, firms can sue them in court. This is, however, only successful with a certain probability.[12]

2.2.1 Model setup

One buyer is matched with one seller. Both firms are risk neutral. A fraction η (η^*) of sellers (buyers) is reliable, that is these firms always fulfill their contracts.[13] If a firm is unreliable and thus does not fulfill its contract voluntarily, the other firm can try to enforce the contract in court which is successful with probability λ (λ^*). When facing an opportunity to cheat, a random firm thus fulfills the contract with probability $\tilde{\lambda} = \eta + (1 - \eta)\lambda$.

There are two periods. In period 0 the seller produces the goods and sends them to the buyer. In period 1, the buyer sells the goods to a final consumer. Because of this time gap between production and final sale, firms have to agree on payment terms. They have two options. First, buyers can pay in advance (cash-in-advance), that is the buyer pays before receiving the goods. Second, they can trade on an open-account, where the buyer pays after delivery, that is the seller extends trade credit to the buyer. A seller produces output for total cost C and sells it to the buyer. The buyer can then sell the goods to final consumers and generate revenues R. For now, we assume that R and C are given exogenously. To finance their transactions, firms can borrow from banks at an interest rate r_b (r_b^*). Firms can deposit surplus funds at banks for a deposit rate of r_d (r_d^*). The seller makes a take-it-or-leave-it offer to the buyer who can choose to accept or reject that offer.[14]

[11] This interest rate difference may be further increased by borrower risk. The point here is that abstracting from the pricing of risk, financial intermediation by banks is costly.

[12] An alternative interpretation would be that all contracts get enforced in court eventually but this generates a legal cost as well as a time delay in settlement.

[13] For the remainder of the paper, all variables related to the buyer are denoted with an asterisk.

[14] In section **??**, we extend the model to allow the seller and the buyer to bargain over the surplus with

Open Account Under open account (trade credit), the seller maximizes:

$$\begin{aligned} \mathrm{E}[\Pi_S^{OA}] &= \tilde{\lambda}^* P^{OA} - (1+r_b)C \\ \text{s.t. } \mathrm{E}[\Pi_B^{OA}] &= R - P^{OA} \geq 0 \end{aligned} \tag{2.1}$$

where P^{OA} is the total payment from the buyer to the seller. Under open account, the seller gets paid P^{OA} with probability $\tilde{\lambda}^*$, while incurring the production costs C with certainty. Because production takes place in period 0 while sales only take place in period 1, the seller has to borrow the production costs C from a bank and pay the interest rate r_b. The maximization is subject to the participation constraint of a reliable buyer, which requires non-negative profits for the buyer. Solving for the optimal P^{OA} that respects the participation constraint implies $P^{OA} = R$. With expected profits of:

$$\mathrm{E}[\Pi_S^{OA}] = \tilde{\lambda}^* R - (1+r_b)C \tag{2.2}$$

Cash-in-Advance Under cash-in-advance, the seller maximizes:

$$\begin{aligned} \mathrm{E}[\Pi_S^{CIA}] &= (1+r_d)(P^{CIA} - C) \\ \text{s.t. } \mathrm{E}[\Pi_B^{CIA}] &= \tilde{\lambda} R - (1+r_b^*)P^{CIA} \geq 0 \end{aligned} \tag{2.3}$$

Under cash-in-advance, the seller gets paid P^{CIA} with certainty. At the same time, a reliable seller incurs production costs C with certainty as well. If the price charged to the buyer exceeds production costs, the seller deposits the surplus funds at a bank for interest rate r_d. The buyer generates revenues R with probability $\tilde{\lambda}$. The buyer pays P^{CIA} with certainty in period 0, borrowing from a bank at interest rate r_b^*. Solving for the optimal P^{CIA} delivers

weights θ and $1-\theta$, that is they maximize the objective function (Nash product): $NP = \Pi_s^{\theta}\Pi_b^{1-\theta}$. This generalizes the model presented in Schmidt-Eisenlohr (2013) that focused on the case of full bargaining power of the seller, while deriving the case of full bargaining power of the buyer in an appendix. It is easily verified that results derived for the more general model nest these two special cases.

$P^{CIA} = \frac{\tilde{\lambda}}{1+r_b^*}R$. With expected profits of:

$$\mathrm{E}[\Pi_S^{CIA}] = (1+r_d)\left(\frac{\tilde{\lambda}}{1+r_b^*}R - C\right) \tag{2.4}$$

Optimal Contract Combining equations (2.41) and (2.44) implies that a buyer-seller pair chooses open account (trade credit) if:

$$\tilde{\lambda^*}R - (1+r_b)C - (1+r_d)\left(\frac{\tilde{\lambda}}{1+r_b^*}R - C\right) \geq 0 \tag{2.5}$$

Now, assume that firms charge a constant markup to final consumers given by μ so that $R = \mu C$.[15] Open account (trade credit) is then preferred over cash-in-advance if:

$$\Delta\Pi = \mathrm{E}[\Pi_S^{OA}] - \mathrm{E}[\Pi_S^{CIA}] = \tilde{\lambda^*}\mu - (1+r_b) - (1+r_d)\left(\frac{\tilde{\lambda}}{1+r_b^*}\ \mu - 1\right) \geq 0 \tag{2.6}$$

2.2.2 Trade Credit and Markups

Taking the derivative of equation (2.46) with respect to μ and rearranging delivers:

$$(1+r_b^*)\ \tilde{\lambda^*} - (1+r_d)\ \tilde{\lambda} \geq 0 \tag{2.7}$$

The condition is quite weak. As long as the buyer's borrowing rate is above the seller's deposit rate and enforcement is not too different between buyers and sellers, trade credit becomes more attractive when the markup goes up. Consider the symmetric case to build intuition, where the buyer and the seller face the same interest rates and enforcement frictions. The condition then simplifies to:

$$r_b > r_d \tag{2.8}$$

[15] We only assume this to simplify the exposition of the main mechanism. In section Appendix 2.B.2, we show that the main results hold with endogenous revenues and costs, R and C, for the special case of CES preferences. We discuss these results below in section 2.6.5.

The following Proposition summarizes our results on trade credit and markups:

Proposition 1 (Trade Credit and Markups)**.** *Suppose* $(1 + r_b^*)\ \tilde{\lambda}^* > (1 + r_d)\ \tilde{\lambda}$. *Then:*

i) The use of open account increases in the markup μ

ii) This effect increases in r_b^* *and* λ^* *and decreases in* r_d *and* λ

Proof. Follows from equation (2.47) ■

Part ii) of Proposition 4 presents additional predictions to test the mechanism explaining trade credit use: the effect of the markup should be stronger when the destination country borrowing rate and the destination country enforcement are higher and when the source country deposit rate and source country enforcement are lower.

2.2.3 Trade Credit and Repeated Interactions

Trade Credit and Learning Consider now the case where an importer and an exporter interact repeatedly. Assume that the two trading partners learn over time about the reliability of their trading partner, so that $\partial\eta_k/\partial k > 0$, where k is the number of previous interactions and η_k is the probability that a firm is reliable after k interactions.[16]

For tractability, consider the trade-off between trade credit and cash-in-advance in the symmetric case where the buyer and the seller face the same interest rates and enforcement frictions (e.g. because they reside in the same country). However, we allow beliefs about types to change at different speeds over time, with $\eta_{k,B}$ and $\eta_{k,S}$, representing the believe about the probability that a buyer or seller are reliable after k interactions, respectively. Equation (2.46) then simplifies to:

$$\frac{\Delta\Pi}{C} = \tilde{\lambda}_{k,B}\ \mu - (1 + r_b) - (1 + r_d)\left(\frac{\tilde{\lambda}_{k,S}}{1 + r_b}\ \mu - 1\right) \tag{2.9}$$

[16]This learning can take multiple forms. One example would be Bayesian updating as in Araujo and Ornelas (2007), Antràs and Foley (2015), Macchiavello and Morjaria (2015) and Monarch and Schmidt-Eisenlohr (2016).

where $\tilde{\lambda}_k$ is increasing in the number of previous interactions k. Taking the derivative with respect to k delivers:

$$\frac{\partial(\Delta\Pi/C)}{\partial k} = \mu(1-\lambda)\,\frac{\partial\eta_{k,B}}{\partial k} - \frac{1+r_d}{1+r_b}\,\mu\,(1-\lambda)\,\frac{\partial\eta_{k,S}}{\partial k} \tag{2.10}$$

This derivative is positive if:

$$\frac{\partial\eta_{k,B}}{\partial k} > \frac{1+r_d}{1+r_b}\,\frac{\partial\eta_{k,S}}{\partial k} \tag{2.11}$$

If learning about the buyer is sufficiently fast relative to learning about the seller, then trade credit becomes more attractive as two firms repeatedly trade with each other. Importantly, the condition allows for some asymmetry in the speed of learning.[17]

Product Complexity In addition, now assume that products differ by their complexity. Following, Hoefele, Schmidt-Eisenlohr, and Yu (2016), assume that product complexity is captured by parameter $\gamma \in [0,1]$, where a higher γ represents a more complex product. Assume further that contract enforcement is harder for more complex products. More specifically, assume that a contract now gets enforced exogenously with probability λ^{γ}. The optimal decision in the symmetric case now becomes:

$$\frac{\Delta\Pi}{C} = \tilde{\lambda}_{k,B}(\gamma)\;\mu - (1+r_b) - (1+r_d)\left(\frac{\tilde{\lambda}_{k,S}(\gamma)}{1+r_b}\;\mu - 1\right) \tag{2.12}$$

with $\tilde{\lambda}_{k,i}(\gamma) = \eta_{k,i} + (1-\eta_{k,i})\lambda^{\gamma}$. Taking the derivative with respect to k delivers:

$$\frac{\partial(\Delta\Pi/C)}{\partial k} = \mu(1-\lambda^{\gamma})\left[\frac{\partial\eta_{k,B}}{\partial k} - \frac{1+r_d}{1+r_b}\,\frac{\partial\eta_{k,S}}{\partial k}\right] \tag{2.13}$$

[17] The speed of learning could be a function of the payment terms. In particular, there could be more learning about the seller under cash-in-advance and more learning about the buyer under open account, due to the asymmetry in the commitment problem. For tractability, we focus on the case where learning is independent of the payment terms. The key assumption is that there is learning in both directions and that the speed of learning is not too dissimilar.

Taking the derivative with respect to γ and rearranging delivers:

$$\frac{\partial^2(\Delta\Pi/C)}{\partial k\partial\gamma} \quad = \quad -\mu\lambda^\gamma \left[\frac{\partial\eta_{k,B}}{\partial k} - \frac{1+r_d}{1+r_b}\frac{\partial\eta_{k,S}}{\partial k}\right] ln(\lambda) \tag{2.14}$$

which is greater equal zero as $\ln\lambda < 0$. That is, the effect of learning on the difference between trade credit and cash-in-advance is stronger for more complex products (higher γ). This is quite intuitive: contracts for more complex products are harder to enforce and hence learning has a stronger effect on a firm's decision problem for these products. The preceding insights are summarized in Proposition 5.

Proposition 2 (Trade Credit and Learning)**.** *Suppose two firms face the same financing costs and enforcement frictions, learning about the buyer is sufficiently fast* $\left(\frac{\partial\eta_{k,B}}{\partial k} > \frac{1+r_d}{1+r_b}\frac{\partial\eta_{k,S}}{\partial k}\right)$, *and the borrowing rate is above the deposit rate,* $r_b > r_d$*. Then:*

1. *Payment is more likely on open account (trade credit) terms, the longer the two firms have traded.*

2. *This effect is the stronger, the more complex is the product that is traded.*

The proposition is quite intuitive. The longer two firms trade with each other, the more likely they will fulfill their contracts. The key advantage of trade credit is that it saves on financing costs as compared to cash-in-advance. Through learning, contract enforcement becomes less of an issue and financing costs differences matter for the contract choice. Therefore, as firms learn that their trading partners are reliable they tend to favor trade credit over cash-in-advance. The effect of repeated interactions is stronger for complex products. With complex products enforcement frictions are more severe to begin with but this also creates a stronger effect from learning, leading to a sharper rise in trade credit within relationships over time.

2.2.4 Price Predictions

We now look at the relationship between the payment terms and prices. To fully assess the price effects, let revenues and final sales prices be endogenous to the payment form. Let p_f^{OA} and p_f^{CIA} denote the prices charged to final consumers and c denote constant marginal costs. Assume that firms operate under monopolistic competition and that consumers have standard CES preferences of the form $q = p^{-\sigma}A$.[18] Then, the relative (per unit) price between open account and cash-in-advance is given by:

$$\frac{P^{OA}/Q^{OA}}{P^{CIA}/Q^{CIA}} = \frac{1+r_b^*}{\tilde{\lambda}} \frac{p_f^{OA}}{p_f^{CIA}} \tag{2.15}$$

Optimal final sales prices are:[19]

$$p_f^{OA} = \frac{1+r_b}{\tilde{\lambda}^*} \frac{\sigma}{\sigma-1} c; \quad p_f^{CIA} = \frac{1+r_b^*}{\tilde{\lambda}} \frac{\sigma}{\sigma-1} c. \tag{2.16}$$

Combining the equations delivers:

$$\frac{P^{OA}/Q^{OA}}{P^{CIA}/Q^{CIA}} = \frac{1+r_b}{\tilde{\lambda}^*} \tag{2.17}$$

Proposition 3. *All else equal, the price charged by the seller to the buyer is higher under open account than under cash in advance. This price difference increases in the interest rate of the seller* r_b *and decreases in the enforcement in the country of the buyer* λ^*.

Proof. See equation (2.55). ■

The proposition is quite intuitive. By providing trade credit (offering open account), the seller takes on the financing cost and the risk that the buyer does not pay after delivery.

[18] More specifically, assume the following demand: $Q = \left(\int q(z)^{\frac{\sigma-1}{\sigma}} dz\right)^{\frac{\sigma}{\sigma-1}}$, with the ideal price index $P = \left(\int p(z)^{1-\sigma} dz\right)^{\frac{1}{1-\sigma}}$. In this context, aggregate demand $A = P^{\sigma}Q$.

[19] Details on the derivation of prices are provided in Appendix 2.B.1.

The seller hence needs to be compensated for these two factors implying a higher unit price paid by the buyer. Interestingly, with a constant markup, this price ratio is independent of the distribution of bargaining power as we show in section **??**.

2.2.5 CES Demand and Wholesale Markup

In this section we discuss the main predictions of the model for the cases of (i) endogenous revenues and costs, and (ii) wholesale markups. This last extension is important, because the wholesale markup is the object we use for testing the predictions of our theory.

CES Preferences We begin reviewing the case of CES preferences. To simplify the discussion, we only present the main results here. Details can be found in Appendix 2.B.3. Assume again standard CES preferences with implied aggregate demand $A = P^{\sigma}Q$. The Nash Products given optimal price decisions can be derived as:

$$NP^{OA} = B\left(\tilde{\lambda}^*\right)^{\theta-1+\sigma}(1+r_b)^{1-\sigma}, \tag{2.18}$$

$$NP^{CIA} = B(1+r_d)^{\theta}(1+r_b^*)^{-\theta+1-\sigma}\left(\tilde{\lambda}\right)^{\sigma}. \tag{2.19}$$

with $B = \theta^{\theta}(1-\theta)^{1-\theta}\frac{c^{1-\sigma}}{\sigma-1}A\left(\frac{\sigma}{\sigma-1}\right)^{-\sigma}$. From this, it follows that open account is preferred over cash in advance if:

$$\left(\tilde{\lambda}^*\right)^{\theta-1+\sigma}(1+r_b)^{1-\sigma} - (1+r_d)^{\theta}(1+r_b^*)^{-\theta+1-\sigma}\left(\tilde{\lambda}\right)^{\sigma} > 0. \tag{2.20}$$

In the symmetric case, this condition simplifies to:

$$(1+r_b)^{\theta} > \left(\tilde{\lambda}\right)^{1-\theta}(1+r_d)^{\theta}, \tag{2.21}$$

the same condition we derived earlier in equation (2.48). To study the role of the markup under CES preferences, we can take the derivative of condition (2.60) with respect to the elasticity of substitution σ which delivers:

$$\left(\tilde{\lambda}^*\right)^{\theta-1+\sigma}(1+r_b)^{1-\sigma}\ln\left(\frac{\tilde{\lambda}^*}{1+r_b}\right)-(1+r_d)^{\theta}(1+r_b^*)^{-\theta+1-\sigma}\left(\tilde{\lambda}\right)^{\sigma}\ln\left(\frac{\tilde{\lambda}}{1+r_b^*}\right) \quad (2.22)$$

In the symmetric case, as $\ln\left(\frac{\tilde{\lambda}}{1+r_b}\right)<0$, this derivative is negative if:

$$(1+r_b)^{\theta}>\left(\tilde{\lambda}\right)^{1-\theta}(1+r_d)^{\theta}, \quad (2.23)$$

which is the case when $r_b > r_d$. More generally, the derivative (2.62) is negative when $r_b^* > r_d$ and interest rates and enforcement are not too different across countries. A negative derivative implies that trade credit becomes more attractive when markups go up (lower σ), in line with Proposition 4. Moreover, as in Proposition 4, equation (2.62) implies that the effect of the markup is stronger when the destination country borrowing rate and the destination country enforcement are higher, and when the source country deposit rate and source country enforcement are lower.

Wholesale Markup So far, we have solved the model for the full markup between final consumer prices and marginal production costs, captured by $\mu = R/C$. In the following we derive results as a function of the intermediate (or wholesale) markups, that is the prices charged to the buyer by the seller over marginal costs, $\mu_W^{OA} = P^{OA}/C^{OA}$ and $\mu_W^{CIA} = P^{CIA}/C^{CIA}$.

With endogenous revenues and costs, wholesale markups differ between open account and cash-in-advance. In appendix 2.B.3 we show that the wholesale markups are given by:

$$\mu_W^{OA} = \frac{1+r_b}{\tilde{\lambda}^*}\left((1-\theta)+\theta\frac{\sigma}{\sigma-1}\right) \quad (2.24)$$

$$\mu_W^{CIA} = \left((1-\theta)+\theta\frac{\sigma}{\sigma-1}\right) \quad (2.25)$$

Equations (2.64) and (2.65) are quite intuitive. They show that the markup obtained by the seller is a fraction of the full markup. This fraction depends on the degree of bargaining power the seller has. In particular, when the seller has all the bargaining power ($\theta = 1$), she captures the full markup between final price and marginal cost. In the other extreme, when the buyer has all the bargaining power ($\theta = 0$), the seller only receives the production costs (adjusted for the financing cost and enforcement friction in the open account case).

In Appendix 2.B.3, we show that in the CES case, open account is preferred over cash in advance if:

$$\left[(\tilde{\lambda}^*)^{\theta-1+\sigma}(1+r_b)^{1-\sigma} - (1+r_d)^{\theta}(1+r_b^*)^{-\theta+1-\sigma}(\tilde{\lambda})^{\sigma}\right]\left(\mu_W^{CIA} - 1\right) > 0. \tag{2.26}$$

Or expressed as a function of the open account wholesale markup:

$$\left[(\tilde{\lambda}^*)^{\theta-1+\sigma}(1+r_b)^{1-\sigma} - (1+r_d)^{\theta}(1+r_b^*)^{-\theta+1-\sigma}(\tilde{\lambda})^{\sigma}\right]\left(\mu_W^{OA} - \frac{1+r_b}{\tilde{\lambda}^*}\right) > 0. \tag{2.27}$$

This conditions imply the same predictions as those derived for the full markups. The preference for trade credit increases in the markup and this effect becomes stronger when r_b^* and λ^* are larger and when r_b and λ are smaller.

2.3 Empirical Framework

2.3.1 Estimating Markups

In the model, markups for each seller and product vary at the level of buyers located in different destinations. In practice, however, the computation of markups at this level of disaggregation is unfeasible, because it imposes severe data requirements that cannot be satisfied when using information for multiple industries and markets.[20] Hence, to test the

[20] Deriving markups at the buyer-seller-product level requires either detailed market or production information at the level of buyers and products. These data requirements are rarely fulfilled. A notable exception is Cajal-Grossi, Macchiavello, and Noguera (2019), who uses detailed information for the Bangladeshi garment industry to derive markups at the buyer-seller-product level.

predictions of the theory we shut down the seller's dimension, and compute markups at the seller-product level using the methodology proposed by De Loecker, Goldberg, Khandelwal, and Pavcnik (2016). The main advantage of this methodology is that it allows to compute markups abstracting from market-level demand information. It only requires to assume that firms minimize cost for each product, and that at least one input is fully flexible.

The starting point in De Loecker, Goldberg, Khandelwal, and Pavcnik (2016), is to consider the firm's cost minimization problem. After rearranging the first-order condition of problem for any flexible input V, the markup of product p produced by firm i at time t (μ_{ipt}) can be computed as the ratio between the output elasticity of product j with respect to the flexible input V (θ^V_{ipt}) and expenditure share of the flexible input V (relative to the sales of product p; $s^V_{ipt} \equiv P^V_{ipt} V_{ipt} / P_{ipt} Q_{ipt}$):[21]

$$\underbrace{\mu_{ipt}}_{\text{Markup}} \equiv \frac{P_{ipt}}{MC_{ipt}} = \frac{\theta^V_{ipt}}{s^V_{ipt}} , \tag{2.28}$$

where P (P^V) denotes the price of output Q (input V), and MC is marginal cost. While the numerator of equation (2.28) – the input-output elasticity of product j – needs to be estimated, the denominator is directly observable in our data. We next explain the procedure we follow for deriving each of these elements.

Input-output elasticity. To estimate the input-output elasticities, we specify production functions for each product p using labor (L), capital(K) and materials (M) as production inputs:

$$Q_{ipt} = \Omega_{it} F(K_{ipt}, L_{ipt}, M_{ipt}) \tag{2.29}$$

[21]The derivation of (2.28) assumes that multi-product firms are equivalent to a collection of single-product firms; thus, this setup does not allow for economies of scope in production. Below, we show that our results also hold for single-product firms.

where Q is physical output, and Ω denotes firm's productivity. There are three important assumptions on equation (2.29). First, the production function is product-specific, which implies that single and multi-product firms use the same technology to produce a given product. However, second, productivity is firm-specific. Finally, as is standard in the estimation of production functions, we assume Hicks-Neutrality, so that Ω is log-additive.

The estimation of (2.29) follows De Loecker, Goldberg, Khandelwal, and Pavcnik (2016) in using the subset of single-product firms to identify the coefficients of the production function.[22] Different from them, we deflate inputs expenditure with firm-specific input price indexes to avoid that the so-called input price bias affect the estimated coefficients (see De Loecker and Goldberg 2014).[23]

Our baseline specification assumes a Cobb-Douglas production function, and allows for the presence of a log-additive non-anticipated shock (ε).[24] Taking logs to (2.29), we obtain

$$q_{ipt} = \alpha_k^j k_{ipt} + \alpha_l^j l_{ipt} + \alpha_m^j m_{ipt} + \omega_{it} + \varepsilon_{ipt} \tag{2.30}$$

The estimation of (2.30) follows Ackerberg, Caves, and Frazer (2015) (henceforth, ACF), who extend the methodology proposed by Olley and Pakes (1996) and Levinsohn and Petrin (2003) to control for the endogeneity of firms' inputs choice –which is based on the actual level of firms' productivity.[25] To identify the coefficients of the production function, we build moments based on the productivity innovation ξ. We specify the following process for the

[22]The reason for using only single-product firms, is that for this set of firms there is no need of specifying how inputs are distributed across individual outputs.

[23]In De Loecker, Goldberg, Khandelwal, and Pavcnik (2016), input prices are not available in their sample of Indian firms, so they implement a correction to control for input price variation. See the Appendix 2.C.1 for a detailed explanation on the construction of the price index we use in our sample of Chilean firms.

[24]A shortcoming of the Cobb-Douglas specification is that it assumes that input-output elasticities are constant across firms, and over time. On the other hand, the Cobb-Douglas specification is widely used, allowing for a more direct comparison of our results with other estimates in the literature. In the robustness checks section we present results with derived using a more flexible Translog production function, which allows for different types of complementarities among production inputs. Results are quantitatively similar, although coefficients are slightly less precisely estimated than with the Cobb-Douglas baseline.

[25]ACF show that the labor elasticity is in most cases unidentified by the two-stage method of Olley and Pakes (1996) and Levinsohn and Petrin (2003).

law of motion of productivity:

$$\omega_{it} = g(\omega_{it-1}, d^x_{it-1}, d^i_{it-1}, d^x_{it-1} \times d^i_{it-1}, \hat{s}_{it-1}) + \xi_{it} \tag{2.31}$$

where d^x is an export dummy, d^i is a categorical variable for periods with positive investment, and $\hat{s}$ is the probability that the firm remains single-product. The endogenous productivity process (2.31) follows the corrections suggested by De Loecker (2013), allowing firms' productivity path to be affected by past exporting and investment decisions. In addition, it follows De Loecker, Goldberg, Khandelwal, and Pavcnik (2016) in including the probability of remaining single-product to correct for the bias that results from firm switching non-randomly from single to multi-product.

The first step of the ACF procedure involves expressing productivity in terms of observables. To do so, we use inverse material demand $h_t(\cdot)$ as in Levinsohn and Petrin (2003) to proxy for unobserved productivity, and estimate expected output $\phi_t(k_{it}, l_{it}, m_{it}; \mathbf{x}_{it})$ to remove the unanticipated shock component ε_{it} from (2.30).[26] Then, the ACF procedure exploits this representation to express productivity as a function of data and parameters: $\omega_{it}(\alpha) = \hat{\phi}_t(\cdot) - \alpha_k k_{it} - \alpha_l l_{it} - \alpha_m m_{it}$, and form the productivity innovation ξ_{it} from (2.31) as a function of the parameters α. The second step of ACF routine forms moment conditions on ξ_{it} to identify all parameters α through GMM:

$$\mathbb{E}(\xi_{it}(\alpha) \cdot \mathbf{Z}_{it}) = 0 \tag{2.32}$$

where $\mathbf{Z}_{it}$ contains lagged materials, labor, and capital, and current capital. Once the parameters are estimated, the input-output elasticities are recovered for each product as $\theta^V_{ipt} \equiv \partial \log Q_{ipt} / \partial \log V_{ipt}$. For the Cobb-Douglas case, $\theta^V_{ipt} = \alpha^j_V$, so that the input-output elasticity is constant for all plants producing a given product p.[27]

[26]The vector $\mathbf{x}_{it}$ includes other variables affecting material demand, such as time and product dummies. We approximate $\phi_t(\cdot)$ with a full second-degree polynomial in capital, labor and materials.

[27]In the Translog case, the input elasticities θ^V_{ipt} depends on firms' input use. This information is directly

Implementation. To derive markups, we use materials as the relevant flexible input to compute the output elasticity. While in principle, labor could also be used to compute markups, the existence of long-term contracts and firing costs make firms less likely to adjust labor after the occurrence of shocks. The second component needed in (2.28) to compute markups is the expenditure share, which requires to identify the assignment of firms' inputs across outputs produced by the firm. To implement this, we follow Garcia-Marin and Voigtländer (2018) and exploit a unique feature of our data: ENIA provide information on total variable costs (labor cost and materials) for each product produced by the firms. We use this information to proxy for product-specific input use assuming that inputs are used approximately in proportion to the variable cost shares, so that the value of materials' expenditure $M_{ipt} = P^V_{ipt} V_{ipt}$ is computed as

$$\tilde{M}_{ipt} \;=\; \rho_{ipt} \cdot \tilde{M}_{it}, \quad \text{where} \quad \rho_{ipt} \;=\; \frac{TVC_{ipt}}{\sum_j TVC_{ipt}}. \tag{2.33}$$

Finally, we compute the expenditure share dividing the value of material inputs by product-specific revenues, which are observed in the data.

Note that the markup measure we compute corresponds to wholesale markups, because our data only provide information for wholesale revenues. Nevertheless, as we discuss in section 2.6.5, all the main predictions of the baseline model hold both when markups are in terms of final consumer and for wholesale price.

2.3.2 Empirical Specifications

Trade Credit and Markups We first test the theoretical predictions on the choice between open account (trade credit) and cash-in-advance. We start with the following baseline

observed in single-product firms. For multi-product firms, we derive inputs' use by each output following the same procedure we apply for computing the expenditure share of the inputs s^V_{ipt} explained next.

regression:

$$\rho_{ipjt} = \beta_1 \ \ln(\mu_{ipt}) + \gamma_1 \ \ln(L_{it}) + \delta_i + \delta_p + \delta_{jt} + \epsilon_{ipjt}, \tag{2.34}$$

where ρ_{ipjt} denotes the share of open account value exported by firm i shipping product p to country j at time t, and μ_{ipt} corresponds to firm-product level markups. The main prediction of the model is that $\beta_1 > 0$, that is, all else equal, firms with larger markups should sell more on open account. The baseline specification include firm fixed-effects (δ_i) to control for time-invariant factors affecting firms' open account share, and product-fixed effects (δ_j) to account for differences in product characteristics leading to dispersion in trade credit use. In addition, we include destination-year fixed effects (δ_{jt}) to account for country-level characteristics directly affecting trade credit choice for all firms, such as the strength of contract enforcement in the destination country (Antràs and Foley 2015). Finally, we include firm employment (L_{it}) to control for the effect of differences in firm size on trade credit use.

Next, we test the second main prediction of the model. According to our theory, the effect of markups on trade credit decreases in the seller's deposit rate and increases in the buyer's borrowing rate and the destination country's contract enforcement. To test these predictions, we modify the baseline specification (2.34) including interaction terms between firm-product markups, interest rates and contract enforcement:

$$\begin{aligned} \rho_{ijpt} \ &= \ \beta_1 \ \ln(\mu_{ipt}) + \beta_2 \ \ln(\mu_{ipt}) \ r^*_{b,jt} + \beta_3 \ \ln(\mu_{ipt}) \ r_{d,jt} \\ &\quad +\beta_4 \ \ln(\mu_{ipt}) \ \lambda^*_{jt} + \delta_{it} + \delta_{jt} + \delta_p + \epsilon_{ijpt}, \end{aligned} \tag{2.35}$$

From the theory we expect $\beta_2 > 0$, $\beta_3 < 0$, and $\beta_4 > 0$: the positive effect of markups increases with the destination-country borrowing rate, r^*_b, decreases with the source-country deposit rate, r_d, and increases with the destination-country enforcement, λ^*.

One potential concern with respect to our baseline specification is that it relies on the exogeneity of markups, which may not hold if exporters charge higher markups in transactions involving trade credit. Our discussion in 2.6.5 reveals that this is indeed the case in the case of CES demand. This concern is, however, mitigated to a large extent when we compute markups at the seller-product level, because the endogenous response of markup to trade credit choice is mitigated when averaging across destinations. Thus, even if firms charge higher markups on transactions involving trade credit, the resulting bias should be relatively modest, especially for firm-products with sales well diversified across markets, or with low participation in export markets. Later in the next section we build on this insight and show that our results largely hold for the subset of firms with low exposure to export markets.

We note, however, that the endogeneity of markups to trade credit choice does not disappear when averaging markups across destinations. To address this concern, we apply a battery of additional tests to evaluate if the bias is substantial, including fixing markups at their initial value for each seller-product, and computing markups at the firm-level (diluting even more the markups' endogeneity). In all cases, results hold to a great extent, suggesting that the potential endogeneity of markups does not drive the correlation between markups and trade credit choice. Finally, note that when testing predictions involving interactions between markups and importing country characteristics, we apply an even more strict test for our theory including firm-year, and firm-product-year fixed effects. The fact that the results are in line with the main theory in this case as well is reassuring and suggests that the overall mechanism holds in the data.

Prices and Trade Credit To test the price predictions of the model, we specify a simple baseline regression testing for a price difference between open account and cash-in-advance by estimating the following regression at the transaction level:

$$\ln UV_{ipjt} \quad = \quad \beta_1 \, \mathbb{I}^{OA}_{ipjt} + \mathbf{\Gamma}'\mathbf{X}_{ijpt} + \delta_{ipj} + \delta_{it} + \delta_{jt} + \varepsilon_{ipjt}, \tag{2.36}$$

where UV_{ipjt} is the unit values of sales by firm i of product p to destination j at time t and X_{ipjt} is a vector of controls including the value of the shipment and the total value of all previous shipments for the same firm-product-destination. The model predicts a higher price for open-account transactions, that is $\beta_1 > 0$. Next, we check the model prediction that the seller interest rate and the buyer enforcement should affect the price difference between open account and cash-in-advance transactions. We thus estimate:

$$\ln UV_{ipjt} = \beta_1 \, \mathbb{I}^{OA}_{ipjt} + \beta_2 \, \mathbb{I}^{LAW*}_{jt} \cdot \mathbb{I}_{OA} + \beta_3 \, r^b_{jt} \cdot \mathbb{I}_{OA} + \mathbf{\Gamma}'\mathbf{X}_{ijpt} + \delta_{ipj} + \delta_{it} + \delta_{jt} + \varepsilon_{ipjt} \quad (2.37)$$

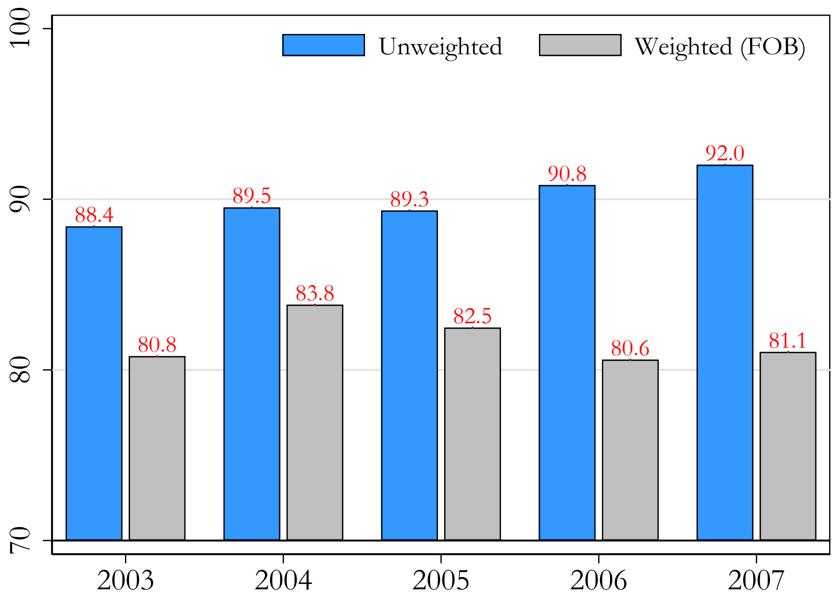
Based on the theory, we expect $\beta_2 < 0$ and $\beta_3 > 0$. We include as controls the FOB value of the transaction to control for the existence of volume discounts, and the cumulative firm-product sales within each destination (excluding the value of the current transaction), to account for the effect of buyer-seller relationships (see Monarch and Schmidt-Eisenlohr 2018).

2.4 Data

We use two main datasets to test the main predictions of the model. Both datasets cover different pieces of information for the universe of Chilean manufacturing exporters over the period 2003-2007. This section reviews the main features of these data sources, describes the sample of our analysis, and provides descriptive evidence on the nature of the data.

The first data source is the Chilean National Customs Service, and provides transaction-level data for the universe of Chilean exports. The data is available for the 90 main destinations of Chilean exports, which account for over 99.7% of the value of overall national exports in our sample period. For each export transaction, the dataset details the identity of the exporter, the importing country, a product description and the 8-digit HS code to which the product belongs, the date of the transaction, the FOB value and volume of the merchandise, and the financing mode of the export transaction. While the data allows to identify if each transactions was paid in advance (cash-in-advance – CIA), post-shipment (open account – OA), or with other modes (such as letters of credit, or other two-part contract), we focus on open account transactions to test the trade credit theory. Open account transactions represent about 90 percent of the transactions, and 83 percent of the export value of manufacturing exporters in our sample (see figure 2.1).

Figure 2.1: Open Account Transactions in the Chilean Data



Notes: The figure shows the aggregate share of open account transactions among Chilean manufacturing exporters, for the period 2003-2007. The blue bars show the share of open account transactions by year; the gray bars weight transactions by their FOB value.

We complement the transaction-level data from customs with production-level data from the *Encuesta Nacional Industrial Anual* (Annual National Industrial Survey – ENIA). ENIA is collected by the Chilean National Statistical Agency (INE), and provides annual production information for the universe of Chilean manufacturing plants with 10 or more employees, according to the International Standard Industrial Classification (ISIC), revision 3. It surveys approximately 4,900 manufacturing plants per year, out of which 20% are exporters. ENIA provides standard micro-level information (e.g., sales, inputs expenditures, employment, investment), and detailed information for each good produced (sales value, production cost, number of unit produced and sold), and inputs purchased by the firm (value and volume for each input purchased by the plant). Outputs and inputs products are defined according to Central Product Classification (CPC) at the 8-digit level, identifying 1,190 products over 2003-2007.[28]

We use two additional data sources to obtain information on the destination countries' characteristics. First, we obtain information for the importing countries' deposit and lending rate, as well as for domestic inflation from the International Monetary Fund's *International Financial Statistics*. We use this data to construct real (ex-post) interest rates as the difference between the nominal rates and the realized inflation in the respective year. Second, we use the Rule of Law index constructed by the World Bank's *World Government Indicator* to proxy for the likelihood of contract enforcement in each country.

The main issue in combining data from Customs and ENIA at the firm-product level is that product are classified using different nomenclatures in both datasets. To deal with this issue, we follow several steps. First, we use United Nations' correspondence tables to determine the list of HS products that could potentially be matched to each CPC product in ENIA.[29] We then merge the resulting dataset with customs data at the firm-HS-year level. This procedure results in two cases: (i) All exported HS products in customs within a firm-year pair are merged to ENIA, and (ii) Only a fraction (or none) of the exported products are matched to ENIA within a firm-year pair. For the latter cases, whenever there is concordance within 4-digit HS categories, we manually merge observations based on HS and CPC product's descriptions. Borderline cases (no clear connection between product descriptions), as well as cases with no concordance at the 4-digit HS level are dropped. In addition, to ensure a consistent dataset, we exclude: (i) plant-product-year observations that have zero values for raw materials expenditure, sales, or product quantities, with extreme values for markups (above the 98th or below the 2nd percentiles), and (ii) destination-year pairs with extreme values of the real borrowing rates to avoid the influence of extreme values

[28]For example, the wine industry (ISIC 3132) is disaggregated by CPC into 4 different categories: "Sparkling wine", "Wine of fresh grapes", "Cider", and "Mosto".

[29]The correspondence table establishes matches between 5-digit CPC and 6-digit HS products. This level of disaggregation corresponds to 783 5-digit CPC products.

resulting from inflationary or deflationary episodes.[30] Table 1 provides summary statistics for the final dataset.[31]

Table 2.1: Summary Statistics

	Mean	Std. Dev.	P25	P50	P75	Obs.
	(1)	(2)	(3)	(4)	(5)	(6)
Transaction Characteristics						
Open Account Dummy	0.9006	0.2992	1	1	1	1,016,523
Export Value (US$)	82,258.1	601,595.4	3,777.2	13,638.5	35,806.8	1,016,523
Unit Value (in logs; demeaned)	0	0.4711	-0.1752	-0.0096	0.1522	1,014,147
Firm-product Characteristics						
Employment (at the firm level)	273.1	522.3	51	119	283	3,546
Markups	1.255	0.538	0.882	1.111	1.466	26,584
# Transactions by firm-product-year	38.2	165.7	1	5	21	26,584
# Destinations by firm-product-year	3.5	5.3	1	1	4	26,584
Country Characteristics						
Rule of Law Index	0.36189	1.00966	-0.56894	0.38070	1.26830	362
Foreign borrowing rate	0.05466	0.04521	0.02717	0.04505	0.06924	362
Chilean deposit rate	0.00929	0.00579	0.00879	0.00883	0.01202	362
Chilean borrowing rate	0.03989	0.00442	0.03625	0.04072	0.04263	362

Notes: The table lists the summary statistics for the variables used in the paper's baseline analysis sample. It comprises transaction-level data for the universe of Chilean manufacturing exporters that can be matched to the Chilean Annual Manufacturing Survey (ENIA), over the period 2003-2007.

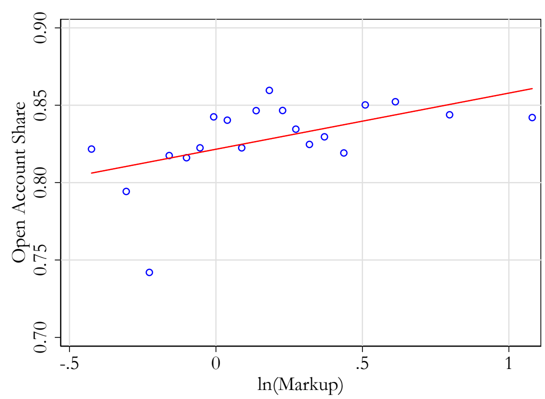
Descriptive Evidence. Before turning to the main econometric results, we explore the raw data seeking to determine whether the main mechanism holds unconditionally. Figure 2.2 shows our main result – trade credit use increases with firm-product level markups. The figure plots a binscatter diagram for the open account share – defined as the percent of export value financed through open account – against firm-product markup (in logarithms).

[30] In practice, this correction drops country-years with real borrowing rates above 35%, and below -4%.

[31] Table 2.D.1 in appendix 2.D provides more detailed summary statistics for markups, aggregated at the 2-digit level.

Both variables represent residuals after taking out country-year fixed effects. As it is evident in the figure, there is a positive relationship between the open account share and markups in the data. This provides support to proposition 4.i): trade credit use increases with markups. The association is relatively stronger for the bottom half of the markup distribution, and it fades out for high markup values. This suggests that the markup mechanism as a reason for firm-to-firm lending is more prominent in firms with low markups. In the econometric specifications, we study if this non-linear relation holds when controlling for other variables affecting trade credit choice and a richer set of fixed-effects.

Figure 2.2: Open Account Share and Markups



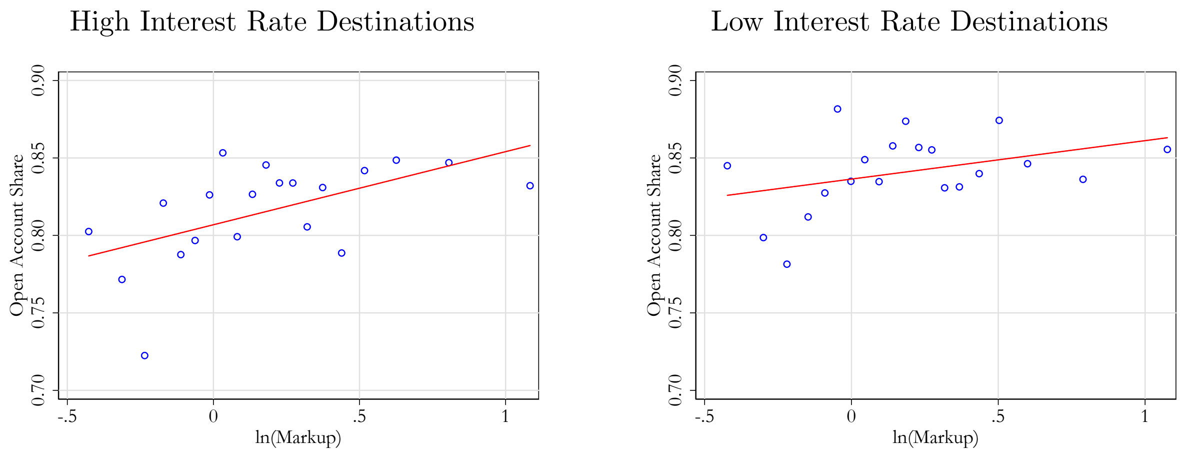
Notes: The figure shows a binscatter diagram for the open account share against markups for a sample of 1,642 Chilean exporters over 2003-2007. Markups are computed at the firm-product level following the methodology by De Loecker et al (2016). Open account share is competed at the firm-product-destination level. Both variables control for country-year fixed effects.

The theoretical framework in section 2.6 predicts that the markup and foreign borrowing rate are complementary in their effect on trade credit choice. To study if this prediction holds in the data, we split the data in terms of trade credit extended to high interest rate and low interest rate destinations, depending on whether the foreign borrowing rate is above or below the median rate across years and destinations, respectively. The resulting binscatter diagrams are plotted in Figure 2.3. The left panel shows trade credit in high interest rate countries, while the right panel focuses on low interest rate countries. Consistent with the theory, the figure shows that the positive correlation between trade credit and markups is stronger for exports to high interest rate countries.

Several other observations based on Figure 2.3 are noteworthy. First, trade credit differences in high- and low-interest rate destinations mostly come from firm-products with low markups. In contrast, firm-products charging high markups extend similar high levels of trade credit, regardless on whether destination has high or low borrowing rates. Second, one may argue that the relatively stronger relation between trade credit and markups in high interest rate destinations is due to other confounding factors, such as low financial development and contract enforcement. The fact that both panels control for destination-year fixed-effects mitigates this possibility, accounting for third factors affecting both high and low markup firm-products.[32] However, this does not completely dissipate questioning regarding identification. In the next section, we present a richer analysis based on regression analysis, allowing us to include additional controls and a richer set of fixed effect to control for alternative mechanisms.

[32] In a complementary exercise – available upon request – we split the sample further using using destination countries' rule of law and financial development. This exercise reveals that most of the effect in high interest rate destinations comes from the fact that low markup firms extend less trade credit to buyers in countries with low contract enforcement and financial development.

Figure 2.3: Open Account Share, Markups and Interest Rates



Notes: The figures show the open account share and markups of Chilean firms. Markups are computed at the firm-product level following the methodology by De Loecker et al (2016). Open account share is computed at the firm-product-destination level. Panel A considers export destinations with borrowing rate above the median rate across destinations. Panel B considers export destinations with borrowing rate below the median rate across destinations.

2.5 Econometric Results

In this section, we test the theoretical predictions of the model we developed in section 2.6 using the Chilean customs-level data introduced in the previous section. We begin studying the predictions on the relationship between firm-product level markups and trade credit choice. Next, we explore how the length of trade relationships affects the choice of contract payment. Finally, we show results for trade credit and product prices.

2.5.1 Trade Credit, Markups and Interest Rates

Baseline Results

We first test the theoretical predictions on the choice between open account (trade credit) and cash-in-advance. Table 2.2 presents results from the estimation of equation (2.34). In line with the model, the estimated coefficient for the markup has a positive sign and is highly significant across all specifications, suggesting that that firms that have a higher markup sell more on trade credit. Column 1 identifies the effect of firm-product markups on trade credit exploiting temporal variation within firm-destinations. Next, in columns 2-3 we study whether the inclusion of destination-year fixed effects changes the quantitative effect of markups on trade credit. As it can be seen, the coefficient on markups is largely unaffected by the inclusion of destination-year fixed-effects. Across specifications, the coefficient on markups is very stable and fluctuates between 0.019 and 0.021. In quantitative terms, the estimated effect suggests that an increase of one standard deviation in firm-product markup (37.3 percent), increases the likelihood of using trade credit by 70–78 basis points.[33]

[33]The moderate magnitude of the markups effect should not be surprising after considering the pervasiveness of trade credit use: in our sample, about 90% of the transactions involve trade credit (see Figure 2.1). Consequently, firm-products with already high open account share have a smaller margin to increase with markups, attenuating the effect of markups on trade credit. Below we revisit the question on the magnitude of the markup mechanism using a logit transformation on the open account share and show that the average response increases substantially using this alternative specification.

Table 2.2: Open Account Share and Firm-Product Markup: Baseline Regressions

Markup Proxy:	— Baseline —			Initial	Average
	(1)	(2)	(3)	(4)	(5)
log(markup)	.0202***	.0211***	.0185***	.0379***	.0731***
	(.00443)	(.00467)	(.00474)	(.0133)	(.0206)
ln(employment)	.00109	.00152	.00248	.000792	.000893
	(.00424)	(.00474)	(.00488)	(.00469)	(.00469)
Firm-Destination FE	✓	—	—	—	—
Year FE	✓	—	—	—	—
HS8 FE	✓	✓	—	✓	✓
Firm FE	—	✓	—	✓	✓
Destination-Year FE	—	✓	✓	✓	✓
Firm-HS8 FE	—	—	✓	—	—
Observations	93,507	93,507	93,507	93,507	93,507
R^2	.691	.368	.408	.368	.368

Notes: The table reports the coefficient estimates from equation (2.34). All regressions are run at the firm-product-destination level (with products defined at the HS8-level). Open account shares are computed as the ratio of the FOB value of open account transactions to the FOB value of all export transactions over a year. Markups are computed at the firm-product level. Standard errors (in parentheses) are clustered at the firm-product level. Key: *** significant at 1%; ** 5%; * 10%.

Next, we move to study whether reverse causality from trade credit choice to markups could explain the positive correlation reported in above. For this, we construct two alternative markup measures, first fixing markups at their value when firm-products are first observed in the sample (column 4, Table 2.2), and then, computing the average markup within firm-product across all years (column 5, Table 2.2). Note that by construction, both specifications shut-down all temporal variation within firm-products, and since we include firm and product fixed effects, the possibility of open account choice leading to higher markups is reduced to a great extent. Nevertheless, in both cases the coefficient on markups is positive and highly significant – despite the limited variation we exploit by imposing firm and product fixed effects.

Table 2.3 provides further evidence on the positive effect of markups on trade credit choice, restricting the sample to the set of firms with relatively low export participation. The aim of this exercise is to check the robustness of the baseline estimates when focusing on a sample where average markups mostly reflect firms' pricing decision in the domestic market. We report results for three different subsamples of firms, according to their overall export share. We begin with the sample of exporters with at most 50% export share, and then move to plants with less than 25%, and 10% export share. As can be seen, when using the baseline markup measure, coefficients lie between .021 and .036 – although the coefficient is less precisely estimated as we increasingly restrict the sample. Results in columns (4) through (6) replicate the exercise using markups fixed at their initial value within firm-products, while columns (7) through (9) use the average markup within firm-products. In all these cases, coefficient are positive, and highly significant, strengthening the evidence on the positive effect of markups on trade credit choice.

Table 2.3: Open Account Share and Markup – Sample of Firms with Low Export Intensity

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Markup measure	—— Baseline ——			—— Initial Markup ——			—— Average Markup ——		
Export share	< 50%	< 25%	< 10%	< 50%	< 25%	< 10%	< 50%	< 25%	< 10%
ln(markup)	.0357***	.0213*	.0251	.0723***	.1010***	.0952***	.1132***	.1298***	.0629*
	(.00903)	(.0122)	(.0194)	(.0181)	(.0208)	(.0289)	(.0255)	(.0287)	(.0357)
ln(employment)	-.0287***	-.0132	-.0189	-.0291***	-.0132	-.0184	-.0287***	-.0126	-.0189
	(.00759)	(.0122)	(.0206)	(.00761)	(.0122)	(.0205)	(.00761)	(.0122)	(.0205)
HS8 FE	✓	✓	✓	✓	✓	✓	✓	✓	✓
Firm FE	✓	✓	✓	✓	✓	✓	✓	✓	✓
Country-Year FE	✓	✓	✓	✓	✓	✓	✓	✓	✓
Observations	40,011	26,655	14,762	40,011	26,655	14,762	40,011	26,655	14,762
R^2	.441	.493	.540	.441	.494	.541	.441	.494	.540

Notes: The table reports the coefficient estimates from equation (2.34). All regressions are run at the firm-product-destination level (with products defined at the HS8-level). Open account shares are computed as the ratio of the FOB value of open account transactions to the FOB value of all export transactions over a year. Markups are computed at the firm-product level. Standard errors (in parentheses) are clustered at the firm-product level. Key: *** significant at 1%; ** 5%; * 10%.

Interactions

We now analyze the second main prediction of the model. According to our theory, the effect of markups on trade credit decreases in the seller's deposit rate and increases in the buyer's borrowing rate and the destination country's contract enforcement. This is an important check for the mechanism, as testing the interaction terms allows for the inclusion of a more complete set of fixed effects, thereby reducing concerns of omitted variable bias.

Table 2.4: Open Account Share and Firm-Product Markup: Heterogeneity

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
ln(markup)	-.0215	-.0182	-.0264	-.0373	—	—	—	—
	(.0199)	(.0310)	(.0316)	(.0328)				
ln(markup)×(r_b^*-r_d)	.291**	—	—	—	.308**	—	—	—
	(.121)				(.136)			
ln(markup)×r_b^*	—	.291**	.325***	.343***	—	.308**	.342**	.364**
		(.121)	(.126)	(.128)		(.136)	(.141)	(.143)
ln(markup)×r_d	—	-.661	-.612	-.682	—	—	—	—
		(2.487)	(2.489)	(2.492)				
ln(markup)× Law	—	—	.0211	—	—	—	.0212	—
			(.0151)				(.0164)	
ln(markup)× DomCred	—	—	—	.0234*	—	—	—	.0252*
				(.0123)				(.0134)
Firm-Year FE	✓	✓	✓	✓	—	—	—	—
HS8 FE	✓	✓	✓	✓	—	—	—	—
Destination-Year FE	✓	✓	✓	✓	✓	✓	✓	✓
Firm-HS8-Year FE	—	—	—	—	✓	✓	✓	✓
Observations	93,507	93,507	93,507	93,507	93,507	93,507	93,507	93,507
R^2	.420	.420	.420	.420	.437	.437	.438	.438

Notes: The table reports the coefficient estimates from equation (2.35). All regressions are run at the firm-product-destination level (with products defined at the HS8-level). Open account shares are computed as the ratio of the FOB value of open account transactions to the FOB value of all export transactions over a year. Markups are computed at the firm-product level (product are defined at the 5-digit CPC level). All regressions control for the logarithm of firm employment. Standard errors (in parentheses) are clustered at the firm-destination level. Key: *** significant at 1%; ** 5%; * 10%.

Table 2.4 present the results from estimating (2.35); we report standard errors clustered at the firm-destination level. Columns (1) through (4) show results using separate firm-year and product (defined at the 8-digit HS level) fixed-effects, while columns (5) through (8) use firm-product-year fixed effects. Consequently, in the latter set of regressions, the level of markups, and its interaction with the domestic lending rate is not identified.

Results in Table 2.4 confirm the main predictions of the model. In Column (1) the coefficient on the interaction between markups and the difference between the buyer's borrowing rate and the seller's deposit rate is positive and significant. Splitting the effects of the interest rate difference into the effects of the two individual interest rates in Columns (2) through (4) further confirms the theory. The coefficient on the seller's deposit rate, r_d, is negative and the coefficient on the buyer's borrowing rate, r_b^* is positive, although only the latter is statistically significant. The interaction interest rate terms have a similar quantitative effect as the baseline markup effect. Consider two firms at the 25th (markup 0.88) and 75th percentile (markup 1.47) of the markup distribution. A one standard deviation higher borrowing rate (4.5 percentage points) in the destination country makes trade credit use in about 77 basis points more likely. Columns (3) and (4) present results on contract enforcement using the destination country's rule of law index, and domestic credit in the destination countries as proxies for contract enforcement. As predicted by the theory, a stronger enforcement abroad strengthens the relationship between the markup and trade credit provision, although the coefficient on the interaction term is only significant at the 10% level for the latter case. Next, columns (5) through (8) repeat the analysis in the previous columns, but include firm-product-year fixed-effects. Results are largely consistent with estimates in the previous columns and the magnitudes of the coefficients are very stable, suggesting that the coefficients are most likely not subject to omitted variable bias occurring at the firm-product level.

To summarize, we find evidence that firms with larger markups extend more trade credit. Moreover, as predicted by the theory, this effect increases in the buyer's borrowing rate and the destination country's rule of law and decreases in the seller's deposit rate.

Robustness and Additional Results

We performed a number of robustness tests using alternative specifications, and considered a series of extensions. In this subsection we discuss the most important of them (in some cases we summarize the results without providing detailed tables; many of these, however, are provided in the Appendix and/or are available on request):

Translog Markups. One potential concern with respect to our results is that they rely on the correct estimation of markups. Our baseline markup measures are computed using input-ouput elasticities derived from a Cobb-Douglas production function (see equation 2.28). One shortcoming of this specification is that it imposes constant elasticities across all firms producing the same product. If firms with higher trade credit use have a lower input-output elasticity, then imposing constant input elasticities would lead us to overestimate the positive relationship between trade credit and markups. To analyze whether the Cobb-Douglas specification drives our results, in Table 2.5, we present results using markups derived from the more flexible translog production function, which allows for a rich set of interactions between the different inputs.[34] Columns (1) through (3) of Table 2.5 estimate the baseline level regression using average translog markups. As in the baseline case, the open account share shows a strong positive relationship with markups. The coefficients in Table 2.5 are very similar and not statistically different than the baseline case (compare them with the corresponding coefficients in Table 2.2). This suggests that input elasticities do not systematically vary with trade credit across firm-products.[35]

[34]We use a second order Translog specification. In this case, materials input elasticity varies with the usage of all input, and is computed as $\theta^M_{ipt} = \alpha^p_m + 2\alpha^p_{mm} m_{ipt} + \alpha^p_{km} k_{ipt} + \alpha^p_{lm} l_{ipt}$.

[35]In Table 2.D.3 the appendix we replicate Table 2.4 using the interaction between translog markups, interest rates and rule of law. Again, results are very similar to the baseline Cobb-Douglas markups.

Table 2.5: Markups and Open Account Share: Alternative Markup Proxies

Markup Proxy:	— Translog Markup —			— Avg. Price-Cost Margin —		
	(1)	(2)	(3)	(4)	(5)	(6)
log(markup)	.0205***	.0187***	.0206***	.0324***	.0324***	.0361*
	(.00452)	(.00447)	(.00493)	(.0116)	(.0116)	(.0187)
ln(employment)	.00645	.00222	.00526	.000602	-.00310	.000267
	(.00429)	(.00445)	(.00497)	(.00407)	(.00416)	(.00474)
Firm-Destination FE	✓	✓	—	✓	✓	—
Year FE	—	✓	—	—	✓	—
HS8 FE	—	✓	✓	—	✓	✓
Firm FE	—	—	✓	—	—	✓
Destination-Year FE	—	—	✓	—	—	✓
Observations	91,291	91,291	91,291	86,746	86,746	86,746
R^2	.664	.665	.368	.668	.669	.361

Notes: The table reports the coefficient estimates from equation (2.34). All regressions are run at the firm-product-destination level (with products defined at the HS8-level). Open account shares are computed as the ratio of the FOB value of open account transactions to the FOB value of all export transactions over a year. Markups in columns 1–3 are computed at the firm-product-year level; average price-cost margins in columns 4–6 are computed at the firm-product level (products are defined at the 5-digit CPC level). Standard errors (in parentheses) are clustered at the firm-product level. Key: *** significant at 1%; ** 5%; * 10%.

Average product margin. An additional proxy for markups that we can compute in our sample are product-level price-cost margins. ENIA report the variable production cost per product, defined as the sum of raw material and direct labor costs involved in the production of each product. Product margins can be derived dividing prices (unit values) over this reported measure of average variable cost. Note that average variable cost are self-reported by managers, making the application of rules of thumb likely. As we discuss in the Appendix, reported margins tend to align more closely with markups and other measures of profitability over longer time periods. Consequently, we use firm-product average margins computed over all periods as an alternative measure of markups. Columns (4) through (6) of Table 2.5 estimate our baseline level regression using average price-cost margins. As can be seen, using margins as a proxy for markups does not affect our results qualitatively.

Coefficients are significantly larger than in the baseline case, but the range of variation of the margins measure is smaller. Standard errors are slightly larger than in our baseline case, which is consistent with the more limited variation of the average margin measure (the unconditional standard deviation of average margins is about one-third smaller than in the Cobb-Douglas benchmark).

Censoring. The dependent variable we use to analyze the effect of markups on trade credit is a proportion with limited variation in the range 0-1. Since average trade credit is relatively high in our sample (around 90% according to Figure 2.1), using the open account share as the main dependent variable limits the potential response of trade credit use to markups for firm-products with initially high trade credit use. In Table 2.6 we revisit the question on the magnitude of the markup mechanism using a logit transformation on the open account share, to pull out its variation over all of the real numbers. We run the following specification:

$$\ln\left(\frac{\rho_{ijpt}}{1-\rho_{ijpt}}\right) = \beta_1 \ \ln(\mu_{ipt}) + \gamma_1 \ \ln(L_{it}) + \delta_i + \delta_p + \delta_{jt} + \epsilon_{ijpt}, \tag{2.38}$$

where ρ denotes the open account share. In this alternative specification, the marginal response of the open account share ρ to markups is non-linear and varies with the amount of trade credit use. In particular, it can be shown that the effect of log-markups over the open account share can be computed as $\beta_1 \times \rho_{ijpt} \times (1 - \rho_{ijpt})$. Plugging in the coefficients from Table 2.6, leads to an estimated implied open account share-markup elasticity of 0.041-0.044 for firm-products with open account share equal to the mean (90 percent in our sample). This is almost twice the baseline coefficients estimated in Table 2.2.

Single-product firms. In order to estimate product-level and markups, we needed to assign inputs to individual outputs in multi-product plants. This is not needed in single-product plants, where inputs are used in the production of a single final product. Columns (1) through (3) in Table 2.7 use only the subset of single-product firms to estimate the relationship between markups and trade credit use following equation (2.34). Despite the fact that the sample is smaller, results for single-product plants remain statistically highly significant and quantitatively similar to the full sample, with a coefficient of 0.036-0.039.

Table 2.6: Logistic Open Account Share Transformation

	(1)	(2)	(3)
log(Markup)	.491***	.465***	.461***
	(.105)	(.102)	(.110)
ln(employment)	.0447	-.0535	.0250
	(.0999)	(.102)	(.113)
Implied Avg. Markup Semi-elasticity	.0442	.0419	.0415
Firm-Destination FE	✓	✓	—
Year FE	—	✓	—
HS8 FE	—	✓	✓
Firm FE	—	—	✓
Destination-Year FE	—	—	✓
Observations	93,507	93,507	93,507
R^2	.645	.646	.365

Notes: The table reports the coefficient estimates from equation (2.34) using a logistic transformation on the open account share as dependent variable. All regressions are run at the firm-product-destination level (with products defined at the HS8-level). Open account shares are computed as the ratio of the FOB value of open account transactions to the FOB value of all export transactions over a year. Standard errors (in parentheses) are clustered at the firm-product level. Key: *** significant at 1%; ** 5%; * 10%.

Firm-level markups. An alternative strategy to determine the robustness of our results is to compute markups at the firm-level. As in the case of single-product firms, computing markups at the firm-level has the advantage that it avoids assigning inputs to individual outputs. Results in columns (4) through (6) in Table 2.7 show that coefficients remain quantitatively similar and stay statistically significant at the 1% level.

Further Robustness Checks. We performed a number of additional robustness checks; here we discuss the results shown in more details in the appendix. The descriptive evidence presented in section 2.4 suggests a nonlinear relationship between markups trade credit use in the raw data. However, when we include a quadratic markup term to the baseline regression, the coefficient – although negative – is typically small and statistically insignificant (t-statistic -0.20). In contrast, the linear markup term stays positive and its magnitude is very similar to the baseline linear specification.[36] We also tested whether adding further control affected the main relation between markups and trade credit. First, we added the log FOB value of firm-product level exports to control for the size of the export shipments. The coefficient on the log FOB value is positive and statistically significant, but the markup coefficient stayed unchanged. Next, to test whether the existence of previous export relations could drive our results, we included the cumulative sum of the FOB value of all previous shipments of the same product to each destination. While the cumulative exports coefficient turned positive and statistically significant, the markup coefficient didn't vary significantly, confirming our main finding.

[36] We also tested potential non-linearities using markup quintiles instead of quadratic terms. Results provide no evidence of a non-linear relation between markups and trade credit use.

Table 2.7: Markups and Open Account Share: Alternative Markup Proxies

Sample/Markup Measure:	— Single-Product Firms —			— Firm-Level Markup —		
	(1)	(2)	(3)	(4)	(5)	(6)
log(Markup)	.0359***	.0377***	.0385***	.0275***	.0272***	.0270***
	(.00726)	(.00745)	(.00782)	(.00511)	(.00510)	(.00536)
ln(employment)	-.0141**	-.0158***	-.0122	.00765*	.00365	.00566
	(.00586)	(.00598)	(.00746)	(.00420)	(.00436)	(.00486)
Firm-Destination FE	✓	✓	—	✓	✓	—
Year FE	—	✓	—	—	✓	—
HS8 FE	—	✓	✓	—	✓	✓
Firm FE	—	—	✓	—	—	✓
Destination-Year FE	—	—	✓	—	—	✓
Observations	44,589	44,589	44,589	94,184	94,184	94,184
R^2	.688	.719	.384	.661	.662	.370

Notes: The table reports the coefficient estimates from equation (2.34). All regressions are run at the firm-product-destination level (with products defined at the HS8-level). Open account shares are computed as the ratio of the FOB value of open account transactions to the FOB value of all export transactions over a year. Markups in columns 1–3 are computed at the firm-product-year level; average price-cost margins in columns 4–6 are computed at the firm-product level (products are defined at the 5-digit CPC level). Standard errors (in parentheses) are clustered at the firm-product level. Key: *** significant at 1%; ** 5%; * 10%.

2.5.2 Trade Credit and Repeated Interactions

We now turn to evidence on trade credit and seller-buyer relationship length. According to proposition 5, trade credit use tends to increase with the length of the relationships. Moreover, the effect is larger for more complex products. To test these predictions, we exploit the data at the transaction-level, and define relationships as in Antràs and Foley (2015) in terms of customer locations.

We begin exploring the relative use of financing terms in our data. Table 2.8 shows the share of transactions financed through the main contracts in our data. Two broad patterns emerge from the data. First, consistent with Figure 2.1, open account is the dominant financing contract in the data. Almost 90 percent of the transactions are paid for this way. In contrast, only 4 percent of the transactions are financed in cash-in-advance terms, and 5 percent in letters of credit terms. Second, when focusing in new customers, the dominance of open account is significantly dampened. Considering only first transactions for new export destinations, 73 percent of them occur on open account terms, 15 percent in cash-in-advance terms, and 8 percent in letter of credits terms. These patterns are strengthened when defining relationships at the location-product level. In this case, open account transactions decrease to 64 percent. Cash-in-advance increases to 20 percent, while the share of letters of credit remains unchanged.

Table 2.8: Relative use of Financing Terms (%)

	Open Account Share	Cash in Advance Share	Letter of Credit Share	Other Payment Forms
All customers	90.0	3.9	5.2	0.9
New Destinations	75.0	13.9	8.7	2.4
New Product and new Destination	67.9	16.6	8.6	6.9

Notes: The Table shows the percentage of transactions financed through open account terms (column 1), cash-in-advance terms (column2), letter of credit terms (column 3) and other forms of payment (column 4). 'New Destinations' and 'New Product and Destinations' only considers the first day of the relationship, defined at the destination and destination-product level, respectively.

This evidence is broadly consistent with results in Antràs and Foley (2015), and suggests that exporters tend to extend more trade credit to repeat as opposed to new customers. Note however, that this finding is more surprising than may be evident. Antràs and Foley (2015) studied the special case of a large U.S. food exporter. From the perspective of buyers, that firm was very reliable both because it was large and had been around for a long time and because it was located in the Unites States, a country with strong contract enforcement. In that special case, it is natural to start with cash-in-advance (or letters of credit) and then move to open account over time. Our empirical analysis show that this pattern holds for the universe of Chilean exporters: many relationships start on cash-in-advance terms and then move to open account. This general pattern does not follow from the basic trade finance model as developed in Schmidt-Eisenlohr (2013) and Antràs and Foley (2015) but can only be rationalized by the model with costly financial intermediation and positive markups derived in this paper.

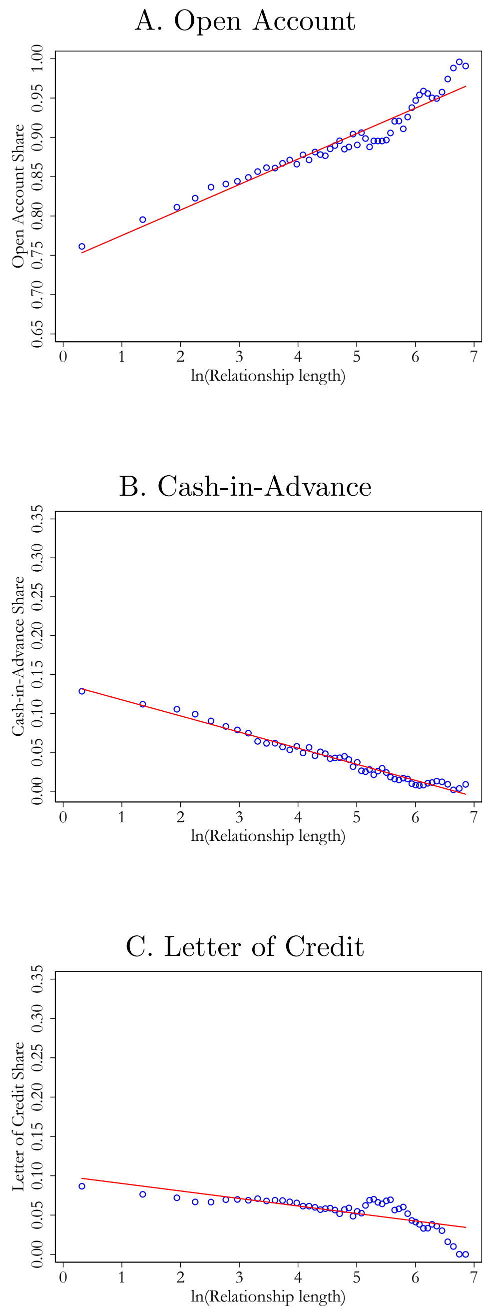
Next, we look at the role of relationship length. We define relationship length as the cumulative number of transactions occurring from the beginning of the relationship.[37] A potential problem for computing this metric lies in the identification of the starting point of the relation. We avoid this issue using transaction level-data from 2001 – two year before the start of our sample – to identify the first time the firm exports to a given customer location.[38] In this way, we reduce the possibility of bias in our results coming from censoring on the starting date of the relationship. Note that we do not have a firm identifier in the destination country. So when we observe a firm's second trade transaction with a destination-product, we do not know if the firm sells to the same buyer or a new buyer. While we acknowledge this data limitation, we see our relationship length measure as a good proxy for the actual underlying relationship length at the firm-pair-product level.

Figure 2.4 plots a binscatter diagram for the logarithm of relationship length and the average use of three main financing contracts in our data. Panel A shows that the use of open account increases almost monotonically with the length of the relationship. Only 75 percent of first transactions are financed in open account terms, but this percentage increases with the age of the relationship, until that eventually all relationships use open account. Panels B and C shows that the opposite occurs with transactions financed through cash-in advance and letters of credit: these contracts tend to be used at the beginning of a relationship, and cease to be used as a relationship ages. These evidence is consistent with proposition 5.1, and suggests that firms are more likely to use trade credit as they learn about their partner's reliability.

[37]An alternative definition of relationship length is in terms of cumulative FOB sales within the relationship. Since results are very similar to the main case, we relegate these results to the appendix.

[38]We have access to transaction-level data for the period 2001-2007, but we can only identify the use of trade credit in a reliable way for the period 2003-2007. This explains the shorter time span used in the main analysis involving trade credit use. See data section.

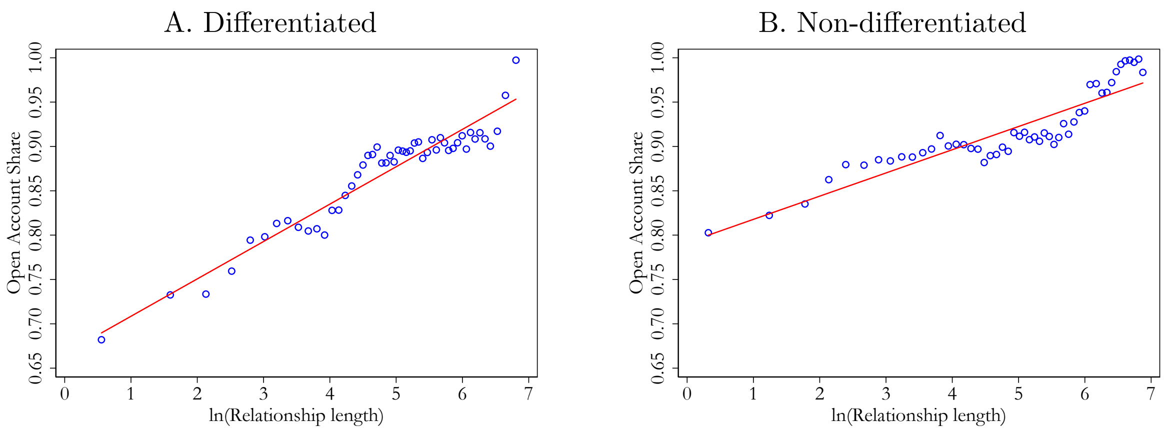
Figure 2.4: Open Account Share and the the Length of the Relationship



Notes: The figure plots the frequency of use of the three main financial contracts in the Chilean data, and the length of the buyer-seller relationship. Relationship length is defined as the cumulative number of transactions occurring from the beginning of the relation. Relationships are defined as customer locations as in Antràs and Foley (2015).

Finally, we study whether the pattern for open account and relationship length varies with the degree of product complexity. We proxy for product complexity using the degree of product differentiation, as defined by Rauch's (1999). Results are shown in Figure 2.5. The plots show that the pattern for the open account share and the length of the relationship is stronger for differentiated (left panel) than for non-differentiated products (right panel). This provides support to proposition 5.2: learning has a stronger effect on trade credit choice for differentiated (complex) products. According to our theory, this is due to the fact that contract enforcement is harder in more complex products and thus learning has a disproportionate effect on the payment choice for these products.

Figure 2.5: Relationships and Open Account Share



Notes: The figure plots the frequency of use of open account contracts and the length of the buyer-seller relationship. Differentiated products are defined (at the 6-digit HS level) according to the liberal product classification of Rauch (1999). Relationship length is defined as the cumulative number of transactions occurring from the beginning of the relation. Relationships are defined as customer locations as in Antràs and Foley (2015).

2.5.3 Trade Credit and Export Prices

We now turn to the price predictions of the model. Results are shown in Table 2.9. We first estimate equation (2.36). As Column (1)-(2) show, the buyer pays a strictly higher price to the seller when trade credit is provided. This is intuitive as the lower price both reflects the fact that the seller bears the financing costs and also faces the risk of non-payment by the buyer. We next present results in columns (3)-(4) on interactions between trade credit use and the destination country rule of law and the seller's borrowing rate (equation 2.37). In line with the model, the open account price decreases with the destination country's rule of law, and increases with the domestic borrowing rate.

Table 2.9: Trade Credit and Export Prices

	(1)	(2)	(3)	(4)
Open Account Dummy	.0213***	.0179***	-.0246	-.0302
	(.00679)	(.00685)	(.0269)	(.0266)
log(FOB sales)	—	.0154***	—	.0155***
		(.00243)		(.00243)
log(Cum. FOB sales)	—	.00238***	—	.00239***
		(.000472)		(.000472)
Open Account Interactions:				
$\times\ r_b$	—	—	1.395*	1.464**
			(.734)	(.724)
$\times\ \mathbb{I}_{LAW}$	—	—	-.0284*	-.0302*
			(.0155)	(.0157)
Firm-HS8-Destination FE	✓	✓	✓	✓
Firm-Year FE	✓	✓	✓	✓
Destination Year FE	✓	✓	✓	✓
Observations	1,006,903	1,006,903	1,006,903	1,006,903
R^2	.971	.971	.971	.971

Notes: The table reports the coefficient estimates from equation (2.36) (column 1-2) and (2.37) columns 3-4). All regressions are run at the level of individual export transactions for each firm-product-destination (with products defined at the HS8-level). Export prices (in logs) are computed as the ratio of FOB value and volume of the transaction. Standard errors (in parentheses) are clustered at the firm-product-destination level. Key: *** significant at 1%; ** 5%; * 10%.

The quantitative effect of trade credit on prices is moderate. According to columns (1)–(2), prices are 1.8%–2.1% higher when transactions are financed with trade credit. Results in columns (3)–(4) also show moderate effects for the domestic borrowing rate and the rule of law interactions. Consider the increase in the Chilean borrowing rate between 2003 (3.4%) and 2007 (4.6%). The results suggest that the higher rate in 2007 led prices to be 1.7% –

1.8% higher than in 2003. Our estimates show a similar quantitative effect for the rule of law interaction. In effect, in destinations with high contract enforcement, prices are between 2.8% and 3.0% lower.

2.6 A model of trade credit and markups

In this section, we extend the model in Schmidt-Eisenlohr (2013) and show how a positive markup and a financial intermediation cost lead to a natural preference for trade credit. In the model there are three key elements. First, there is a time delay between the production of the goods by the seller and the sale of the goods by the buyer. Second, financing is costly. To pay for goods or production costs, firms have to borrow funds from the financial sector. Firms can also deposit surplus liquidity as deposits with the banking sector. Importantly, because of regulation, monitoring and general overhead costs, banks charge a higher interest rate when lending funds to firms than the interest rates they pay to depositors.[39] Third, there is imperfect contract enforcement. When a buyer or seller do not fulfill their contractual obligations, firms can sue them in court. This is, however, only successful with a certain probability.[40]

2.6.1 Model setup

One buyer is matched with one seller. Both firms are risk neutral. A fraction η (η^*) of sellers (buyers) is reliable, that is these firms always fulfill their contracts.[41] If a firm is unreliable and thus does not fulfill its contract voluntarily, the other firm can try to enforce the contract in court which is successful with probability λ (λ^*). When facing an opportunity to cheat, a random firm thus fulfills the contract with probability $\tilde{\lambda} = \eta + (1-\eta)\lambda$.

[39] This interest rate difference may be further increased by borrower risk. The point here is that abstracting from the pricing of risk, financial intermediation by banks is costly.

[40] An alternative interpretation would be that all contracts get enforced in court eventually but this generates a legal cost as well as a time delay in settlement.

[41] For the remainder of the paper, all variables related to the buyer are denoted with an asterisk.

There are two periods. In period 0 the seller produces the goods and sends them to the buyer. In period 1, the buyer sells the goods to a final consumer. Because of this time gap between production and final sale, firms have to agree on payment terms. They have two options. First, buyers can pay in advance (cash-in-advance), that is the buyer pays before receiving the goods. Second, they can trade on an open-account, where the buyer pays after delivery, that is the seller extends trade credit to the buyer. A seller produces output for total cost C and sells it to the buyer. The buyer can then sell the goods to final consumers and generate revenues R. For now, we assume that R and C are given exogenously. To finance their transactions, firms can borrow from banks at an interest rate r_b (r_b^*). Firms can deposit surplus funds at banks for a deposit rate of r_d (r_d^*).

The seller and the buyer bargain over the surplus with weights θ and $1-\theta$, that is they maximize the objective function (Nash product): $NP = \Pi_s^\theta \Pi_b^{1-\theta}$.[42] Bargaining takes place under the assumption that the sharing rule has to be acceptable to a reliable trading partner, while payoffs account for the fact that a firm may be matched with an unreliable firm.[43]

Open Account Under open account (trade credit), the two firms solve the following problem:

$$NP^{OA} = \mathrm{E}[\Pi_S^{OA}]^\theta [\Pi_B^{OA}]^{1-\theta} = (\underbrace{\tilde{\lambda}^* P^{OA} - (1+r_b)C}_{\text{Seller Profit}})^\theta (\underbrace{R - P^{OA}}_{\text{Buyer Profit}})^{1-\theta} \tag{2.39}$$

where P^{OA} is the total payment from the buyer to the seller. The first part of the Nash product represents the expected profits of the seller. Under open account, the seller gets paid P^{OA} with probability $\tilde{\lambda}^*$, while incurring the production costs C with certainty. Because production takes place in period 0 while sales only take place in period 1, the seller has to borrow the production costs C from a bank and pay the interest rate r_b. The second part of

[42]This generalizes the model presented in Schmidt-Eisenlohr (2013) that focused on the case of full bargaining power of the seller, while deriving the case of full bargaining power of the buyer in an appendix. It is easily verified that results derived for the more general model nest these two special cases.

[43]That is, we focus on contracts that are determined by reliable firms, with unreliable firms imitating the contract choice of reliable firms.

the Nash product represents the expected profits of the buyer. Solving for the optimal P^{OA} that maximizes NP^{OA} delivers:

$$P^{OA} = \frac{\theta\tilde{\lambda}^* R + (1-\theta)(1+r_b)C}{\tilde{\lambda}^*} \tag{2.40}$$

The expected Nash product under open account is thus:

$$NP^{OA} = \theta^\theta (1-\theta)^{1-\theta} (\tilde{\lambda}^*)^{\theta-1} \left(\tilde{\lambda}^* R - (1+r_b)C\right) \tag{2.41}$$

Cash-in-Advance Under cash-in-advance, the two firms solve the following problem:

$$NP^{CIA} = \mathrm{E}[\Pi_S^{CIA}]^\theta [\Pi_B^{CIA}]^{1-\theta} = (\underbrace{(1+r_d)(P^{CIA} - C)}_{\text{Seller Profit}})^\theta (\underbrace{\tilde{\lambda} R - (1+r_b^*)P^{CIA}}_{\text{Buyer Profit}})^{1-\theta} \tag{2.42}$$

The first part of the Nash product again shows the expected profits of a reliable seller. Under cash-in-advance, the seller gets paid P^{CIA} with certainty. At the same time, a reliable seller incurs production costs C with certainty as well. If the price charged to the buyer exceeds production costs, the seller deposits the surplus funds at a bank for interest rate r_d. The second part of the Nash product captures the expected profits of the buyer. Now, the buyer generates revenues R with probability $\tilde{\lambda}$. The buyer pays P^{CIA} with certainty in period 0, borrowing from a bank at interest rate r_b^*. Solving for the optimal P^{CIA} that maximizes NP^{CIA} delivers:

$$P^{CIA} = \frac{\theta\tilde{\lambda} R + (1-\theta)(1+r_b^*)C}{1+r_b^*} \tag{2.43}$$

With an expected Nash product of:

$$NP^{CIA} = \theta^\theta (1-\theta)^{1-\theta} (1+r_d)^\theta (1+r_b^*)^{-\theta} \left(\tilde{\lambda} R - (1+r_b^*)C\right) \tag{2.44}$$

Optimal Contract Combining equations (2.41) and (2.44) implies that a buyer-seller pair chooses open account (trade credit) if:

$$\theta^{\theta}(1-\theta)^{1-\theta}\left[(\tilde{\lambda}^{*})^{\theta-1}\left(\tilde{\lambda}^{*}R-(1+r_b)C\right)-(1+r_d)^{\theta}(1+r_b^{*})^{-\theta}\left(\tilde{\lambda}R-(1+r_b^{*})C\right)\right]>0 \quad (2.45)$$

Now, assume that firms charge a constant markup to final consumers given by μ so that $R=\mu C$.[44] Open account (trade credit) is then preferred over cash-in-advance if:

$$(\tilde{\lambda}^{*})^{\theta-1}\left(\tilde{\lambda}^{*}\mu-(1+r_b)\right)-(1+r_d)^{\theta}(1+r_b^{*})^{-\theta}\left(\tilde{\lambda}\mu-(1+r_b^{*})\right)>0 \quad (2.46)$$

2.6.2 Trade Credit and Markups

Taking the derivative of equation (2.46) with respect to μ and rearranging delivers:

$$(1+r_b^{*})^{\theta}\left(\tilde{\lambda}^{*}\right)^{\theta}-(1+r_d)^{\theta}\,\tilde{\lambda}>0 \quad (2.47)$$

The condition is quite weak. As long as the buyer's borrowing rate is above the seller's deposit rate and enforcement is not too different between buyers and sellers, trade credit becomes more attractive when the markup goes up. Consider the symmetric case to build intuition, where the buyer and the seller face the same interest rates and enforcement frictions. The condition then simplifies to:

$$(1+r_b)^{\theta}>(\tilde{\lambda})^{1-\theta}(1+r_d)^{\theta}. \quad (2.48)$$

It is easy to see that a sufficient condition for (2.48) to hold is that the borrowing rate exceeds the deposit rate. The following Proposition summarizes our results on trade credit and markups:

[44] We only assume this to simplify the exposition of the main mechanism. In section Appendix 2.B.2, we show that the main results hold with endogenous revenues and costs, R and C, for the special case of CES preferences. We discuss these results below in section 2.6.5.

Proposition 4 (Trade Credit and Markups). *Suppose* $(1+r_b^*)^\theta \left(\tilde{\lambda}^*\right)^\theta > (1+r_d)^\theta \tilde{\lambda}$. *Then:*

i) The use of open account increases in the markup μ

ii) This effect increases in r_b^* *and* λ^* *and decreases in* r_d *and* λ

Proof. Follows from equation (2.47) ∎

Part ii) of Proposition 4 presents additional predictions to test the mechanism explaining trade credit use: the effect of the markup should be stronger when the destination country borrowing rate and the destination country enforcement are higher and when the source country deposit rate and source country enforcement are lower.

2.6.3 Trade Credit and Repeated Interactions

Trade Credit and Learning Consider now the case where an importer and an exporter interact repeatedly. Assume that the two trading partners learn over time about the reliability of their trading partner, so that $\partial\eta_k/\partial k > 0$, where k is the number of previous interactions and η_k is the probability that a firm is reliable after k interactions.[45]

For tractability, consider the trade-off between trade credit and cash-in-advance in the symmetric case where the buyer and the seller face the same interest rates and enforcement frictions (e.g. because they reside in the same country). Equation (2.46) then simplifies to:

$$(\tilde{\lambda}_k)^{\theta-1}\left(\tilde{\lambda}_k\mu-(1+r_b)\right)-(1+r_d)^\theta(1+r_b)^{-\theta}\left(\tilde{\lambda}_k\mu-(1+r_b)\right)>0 \qquad (2.49)$$

where $\tilde{\lambda}_k$ is increasing in the number of previous interactions k. Assume further that learning is symmetric, that is with each interaction, independent of the payment form used - the two

[45]This learning can take multiple forms. One example would be Bayesian updating as in Araujo and Ornelas (2007), Antràs and Foley (2015), Macchiavello and Morjaria (2015) and Monarch and Schmidt-Eisenlohr (2016).

trading partners learn about each other.[46] Taking the derivative with respect to η_k delivers:

$$\frac{\partial\left(NP^{OA}-NP^{CIA}\right)}{\partial\eta_k}=\left(\mu\left[\theta\tilde{\lambda}_k^{\theta-1}-\left(\frac{1+r_d}{1+r_b}\right)^{\theta}\right]+(1-\theta)(1+r_b)\left(\tilde{\lambda}_k\right)^{\theta-2}\right)(1-\lambda) \quad (2.50)$$

First, consider the special case $\theta = 1$ where the seller has all bargaining power. Then, the condition simplifies to:

$$\frac{\partial\left(NP^{OA}-NP^{CIA}\right)}{\partial\eta_k}|_{\theta=1}=\mu\left[1-\frac{1+r_d}{1+r_b}\right](1-\lambda) \quad (2.51)$$

This derivative is positive as long as the borrowing rate exceeds the deposit rate. Then, open account becomes more attractive the more often the two firms interacted with each other. As the bargaining power of the seller, θ, declines, this effect becomes less clear-cut. For the other extreme case where the buyer has all bargaining power, the derivative changes to:

$$\frac{\partial\left(NP^{OA}-NP^{CIA}\right)}{\partial\eta_k}|_{\theta=0}=\left(\frac{1+r_b}{(\tilde{\lambda})^2}-\mu\right)(1-\lambda), \quad (2.52)$$

which does not have a clear sign.

Product Complexity In addition, now assume that products differ by their complexity. Following, Hoefele, Schmidt-Eisenlohr, and Yu (2016), assume that product complexity is captured by parameter $\gamma \in [0,1]$, where a higher γ represents a more complex product. Assume further that contract enforcement is harder for more complex products. More specifically, assume that a contract now gets enforced exogenously with probability λ^{γ}. The optimal decision in the symmetric case now becomes:

$$(\tilde{\lambda}_k(\gamma))^{\theta-1}\left(\tilde{\lambda}_k(\gamma)\mu-(1+r_b)\right)-(1+r_d)^{\theta}(1+r_b)^{-\theta}\left(\tilde{\lambda}_k(\gamma)\mu-(1+r_b)\right)>0 \quad (2.53)$$

[46] In principle, the speed of learning could be a function of the payment terms. That is there could be more learning about the seller under cash-in-advance and vice versa. As the general case becomes intractable quite quickly, we restrict the analysis to the symmetric case here to show the general intuition.

with $\tilde{\lambda}_k(\gamma) = \eta_k + (1-\eta_k)\lambda^\gamma$. Taking the derivative with respect to η_k delivers:

$$\frac{\partial\left(NP^{OA} - NP^{CIA}\right)}{\partial\eta_k} = \left(\mu\left[\theta\tilde{\lambda}_k(\gamma)^{\theta-1} - \left(\frac{1+r_d}{1+r_b}\right)^{\theta}\right] + (1-\theta)(1+r_b)\left(\tilde{\lambda}_k(\gamma)\right)^{\theta-2}\right)(1-\lambda^\gamma) \tag{2.54}$$

Taking the derivative with respect to γ and rearranging delivers:

$$\begin{aligned}\frac{\partial\left(NP^{OA} - NP^{CIA}\right)}{\partial\eta_k\partial\gamma} &= -\left((1-\lambda^\gamma)\left(\mu\theta + (2-\theta)\frac{(1+r_b)}{\tilde{\lambda}_k(\gamma)}\right)(1-\eta_k) + (1+r_b)\right) \\ &\quad \left(\tilde{\lambda}_k(\gamma)\right)^{\theta-2}(1-\theta)\lambda^\gamma \ln\lambda,\end{aligned}$$

which is greater equal zero as $\ln\lambda < 0$. That is, the effect of learning on the difference between trade credit and cash-in-advance is stronger for more complex products (higher γ). This is quite intuitive: contracts for more complex products are harder to enforce and hence learning has a stronger effect on a firm's decision problem for these products. The preceding insights are summarized in Proposition 5.

Proposition 5 (Trade Credit and Learning)**.** *Suppose two firms in the same country trade with each other, learning is symmetric and the borrowing rate is above the deposit rate,* $r_b > r_d$*. Then:*

1. *If the seller has all bargaining power ($\theta = 1$), payment is more likely on open account (trade credit) terms, the longer the two firms have traded.*

2. *If the seller does not have all bargaining power ($\theta < 1$), learning increases the attractiveness of trade credit, the more complex is the product that is traded.*

The proposition is quite intuitive. The longer two firms trade with each other, the more likely they will fulfill their contracts. The key advantage of trade credit is that it saves on financing costs as compared to cash-in-advance. Through learning, contract enforcement becomes less of an issue and financing costs differences matter for the contract choice. Therefore, as firms learn that their trading partners are reliable they tend to favor trade credit over cash-in-advance. The effect of repeated interactions is stronger for complex products. With complex products enforcement frictions are more severe to begin with but this also creates a stronger effect from learning, leading to a sharper rise in trade credit within relationships over time.

2.6.4 Price Predictions

We now look at the relationship between the payment terms and prices. To fully assess the price effects, let revenues and final sales prices be endogenous to the payment form. Let p_f^{OA} and p_f^{CIA} denote the prices charged to final consumers and c denote constant marginal costs. Assume that firms operate under monopolistic competition and that consumers have standard CES preferences of the form $q = p^{-\sigma} A$.[47] Then, the relative (per unit) price between open account and cash-in-advance is given by:

$$\frac{P^{OA}/Q^{OA}}{P^{CIA}/Q^{CIA}} = \frac{1+r_b^*}{\tilde{\lambda}^*} \left[\frac{\theta \tilde{\lambda}^* p_f^{OA} + (1-\theta)(1+r_b)c}{\theta \tilde{\lambda} p_f^{CIA} + (1-\theta)(1+r_b^*)c} \right] \tag{2.55}$$

Optimal final sales prices are:[48]

$$p_f^{OA} = \frac{1+r_b}{\tilde{\lambda}^*} \frac{\sigma}{\sigma-1} c; \quad p_f^{CIA} = \frac{1+r_b^*}{\tilde{\lambda}} \frac{\sigma}{\sigma-1} c. \tag{2.56}$$

Combining the equations delivers:

$$\frac{P^{OA}/Q^{OA}}{P^{CIA}/Q^{CIA}} = \frac{1+r_b}{\tilde{\lambda}^*} \tag{2.57}$$

Proposition 6. *All else equal, the price charged by the seller to the buyer is higher under open account than under cash in advance. This price difference increases in the interest rate*

[47]More specifically, assume the following demand: $Q = \left(\int q(z)^{\frac{\sigma-1}{\sigma}} dz\right)^{\frac{\sigma}{\sigma-1}}$, with the ideal price index $P = \left(\int p(z)^{1-\sigma} dz\right)^{\frac{1}{1-\sigma}}$. In this context, aggregate demand $A = P^{\sigma} Q$.

[48]Details on the derivation of prices are provided in Appendix 2.B.1.

of the seller r_b and decreases in the enforcement in the country of the buyer λ^*.

Proof. See equation (2.55). ■

The proposition is quite intuitive. By providing trade credit (offering open account), the seller takes on the financing cost and the risk that the buyer does not pay after delivery. The seller hence needs to be compensated for these two factors implying a higher unit price paid by the buyer. Interestingly, with a constant markup, this price ratio is independent of the distribution of bargaining power.

2.6.5 CES Demand and Wholesale Markup

In this section we discuss the main predictions of the model for the cases of (i) endogenous revenues and costs, and (ii) wholesale markups. This last extension is important, because the wholesale markup is the object we use for testing the predictions of our theory.

CES Preferences We begin reviewing the case of CES preferences. To simplify the discussion, we only present the main results here. Details can be found in Appendix 2.B.3. Assume again standard CES preferences with implied aggregate demand $A = P^{\sigma}Q$. The Nash Products given optimal price decisions can be derived as:

$$NP^{OA} = B\left(\tilde{\lambda}^*\right)^{\theta-1+\sigma}(1+r_b)^{1-\sigma}, \tag{2.58}$$

$$NP^{CIA} = B(1+r_d)^{\theta}(1+r_b^*)^{-\theta+1-\sigma}\left(\tilde{\lambda}\right)^{\sigma}. \tag{2.59}$$

with $B = \theta^{\theta}(1-\theta)^{1-\theta}\frac{c^{1-\sigma}}{\sigma-1}A\left(\frac{\sigma}{\sigma-1}\right)^{-\sigma}$. From this, it follows that open account is preferred over cash in advance if:

$$\left(\tilde{\lambda}^*\right)^{\theta-1+\sigma}(1+r_b)^{1-\sigma} - (1+r_d)^{\theta}(1+r_b^*)^{-\theta+1-\sigma}\left(\tilde{\lambda}\right)^{\sigma} > 0. \tag{2.60}$$

In the symmetric case, this condition simplifies to:

$$(1+r_b)^\theta > \left(\tilde{\lambda}\right)^{1-\theta}(1+r_d)^\theta, \tag{2.61}$$

the same condition we derived earlier in equation (2.48). To study the role of the markup under CES preferences, we can take the derivative of condition (2.60) with respect to the elasticity of substitution σ which delivers:

$$\left(\tilde{\lambda}^*\right)^{\theta-1+\sigma}(1+r_b)^{1-\sigma}\ln\left(\frac{\tilde{\lambda}^*}{1+r_b}\right)-(1+r_d)^\theta(1+r_b^*)^{-\theta+1-\sigma}\left(\tilde{\lambda}\right)^\sigma\ln\left(\frac{\tilde{\lambda}}{1+r_b^*}\right) \tag{2.62}$$

In the symmetric case, as $\ln\left(\frac{\tilde{\lambda}}{1+r_b}\right)<0$, this derivative is negative if:

$$(1+r_b)^\theta > \left(\tilde{\lambda}\right)^{1-\theta}(1+r_d)^\theta, \tag{2.63}$$

which is the case when $r_b > r_d$. More generally, the derivative (2.62) is negative when $r_b^* > r_d$ and interest rates and enforcement are not too different across countries. A negative derivative implies that trade credit becomes more attractive when markups go up (lower σ), in line with Proposition 4. Moreover, as in Proposition 4, equation (2.62) implies that the effect of the markup is stronger when the destination country borrowing rate and the destination country enforcement are higher, and when the source country deposit rate and source country enforcement are lower.

Wholesale Markup So far, we have solved the model for the full markup between final consumer prices and marginal production costs, captured by $\mu = R/C$. In the following we derive results as a function of the intermediate (or wholesale) markups, that is the prices charged to the buyer by the seller over marginal costs, $\mu_W^{OA} = P^{OA}/C^{OA}$ and $\mu_W^{CIA} = P^{CIA}/C^{CIA}$.

With endogenous revenues and costs, wholesale markups differ between open account and cash-in-advance. In appendix 2.B.3 we show that the wholesale markups are given by:

$$\mu_W^{OA} = \frac{1+r_b}{\tilde{\lambda}^*}\left((1-\theta)+\theta\frac{\sigma}{\sigma-1}\right) \quad (2.64)$$

$$\mu_W^{CIA} = \left((1-\theta)+\theta\frac{\sigma}{\sigma-1}\right) \quad (2.65)$$

Equations (2.64) and (2.65) are quite intuitive. They show that the markup obtained by the seller is a fraction of the full markup. This fraction depends on the degree of bargaining power the seller has. In particular, when the seller has all the bargaining power ($\theta = 1$), she captures the full markup between final price and marginal cost. In the other extreme, when the buyer has all the bargaining power ($\theta = 0$), the seller only receives the production costs (adjusted for the financing cost and enforcement friction in the open account case).

In Appendix 2.B.3, we show that in the CES case, open account is preferred over cash in advance if:

$$\left[(\tilde{\lambda}^*)^{\theta-1+\sigma}(1+r_b)^{1-\sigma} - (1+r_d)^{\theta}(1+r_b^*)^{-\theta+1-\sigma}(\tilde{\lambda})^{\sigma}\right]\left(\mu_W^{CIA}-1\right) > 0. \quad (2.66)$$

Or expressed as a function of the open account wholesale markup:

$$\left[(\tilde{\lambda}^*)^{\theta-1+\sigma}(1+r_b)^{1-\sigma} - (1+r_d)^{\theta}(1+r_b^*)^{-\theta+1-\sigma}(\tilde{\lambda})^{\sigma}\right]\left(\mu_W^{OA}-\frac{1+r_b}{\tilde{\lambda}^*}\right) > 0. \quad (2.67)$$

This conditions imply the same predictions as those derived for the full markups. The preference for trade credit increases in the markup and this effect becomes stronger when r_b^* and λ^* are larger and when r_b and λ are smaller.

2.7 Conclusions

Trade credit is the most important form of short-term finance for U.S. firms. This paper presented a theory that explains the prominence of trade credit for firm-to-firm transactions by the ability of firms to save on financial costs when there are positive markups and when financial intermediation is costly. The theory also predicts that trade credit use should become more prevalent the longer two firms trade with each other, an effect that should be stronger for complex products. Chilean firm-level data supports all predictions of the model.

The model is also qualitatively consistent with recent developments in aggregate U.S. data that show rising markups and more use of trade credit over time. Based on our model, the rise in markups identified by De Loecker and Eeckhout (2017) should affect financial markets. As higher markups make trade credit more attractive, firms may rely more on that financing form and less on the formal financial sector. Future work should shed more light on the macro implications of our findings and on how heterogeneity in the adoption of trade credit may affect the size and the development of the financial sector. The last point may be particularly relevant in the context of developing and emerging economies where financial frictions are larger and hence the potential savings from using trade credit more prominent.

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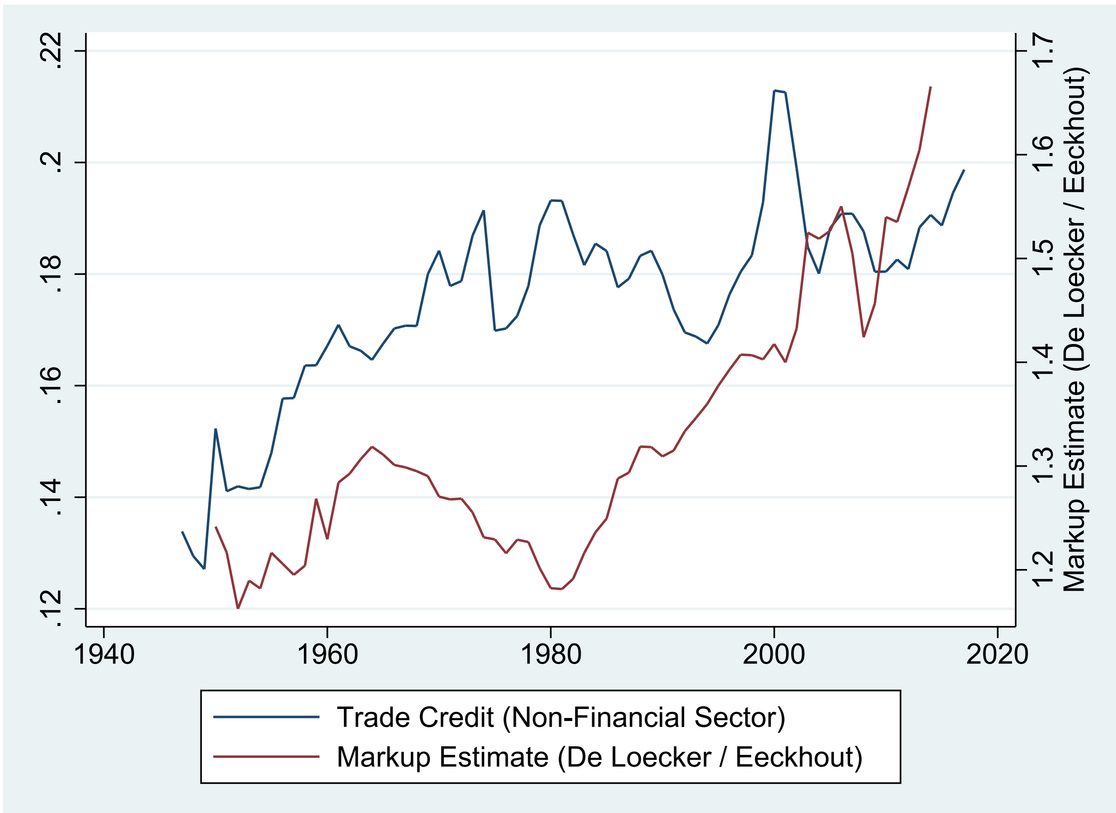
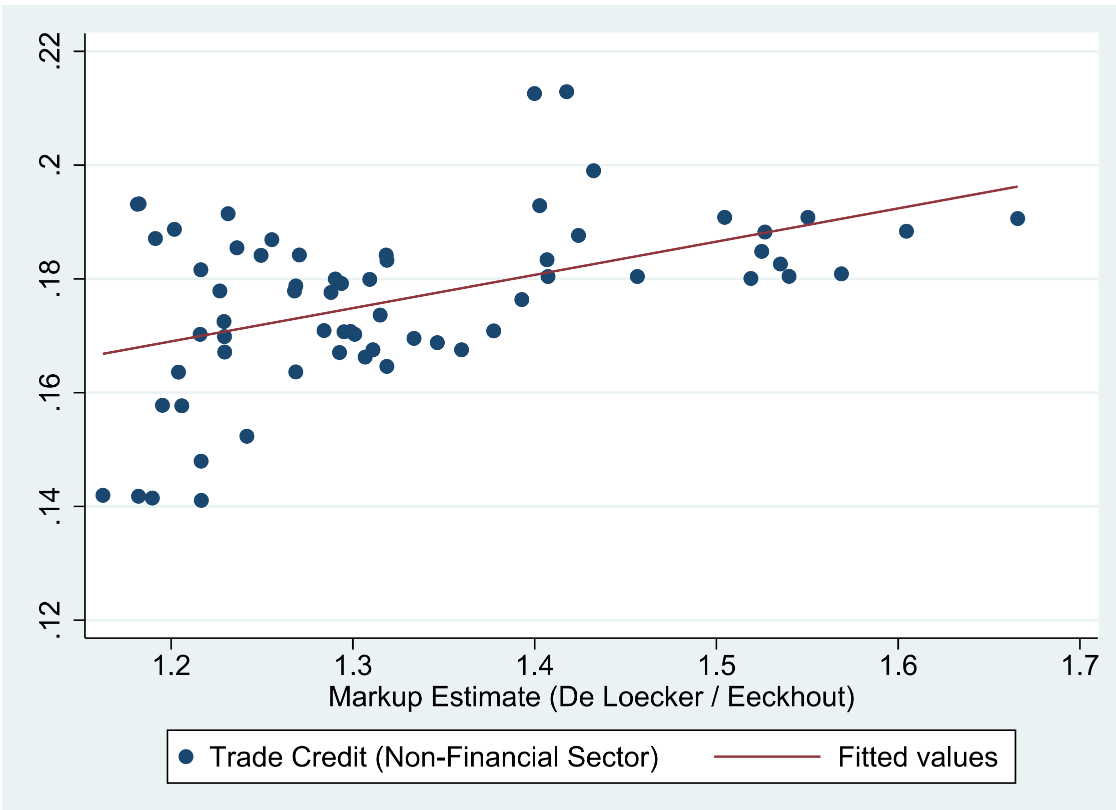
2.A Trade Credit and Markups in the United States over time

Figure 2.A.1: Trade Credit and Markups in the U.S.



Notes: This figure shows the time series of the total trade credit receivables of the non-financial corporate and non-corporate sectors over GDP on the left Y-axis. On the right Y-axis it shows the markups as estimated by De Loecker and Eeckhout (2017).

Figure 2.A.2: Trade Credit and Markups in the U.S.



Notes: This figure plots the total trade credit receivables of the non-financial corporate and non-corporate sectors against the markups as estimated by De Loecker and Eeckhout (2017).

2.B Theory Appendix

2.B.1 Derivation of Final Consumer Prices

In this subsection, we derive the prices charged to final consumers under CES preferences.

Open Account The Nash Product under Open Account is given by:

$$NP^{OA} = B^{OA}\left(\tilde{\lambda}^{*}R - (1+r_b)C\right), \tag{68}$$

with $B^{OA} = \theta^{\theta}(1-\theta)^{1-\theta}(\tilde{\lambda}^{*})^{\theta-1}$. Plugging in the demand $q = p_f^{-\sigma}A$ delivers:

$$NP^{OA} = AB^{OA}\left(\tilde{\lambda}^{*}(p_f^{OA})^{1-\sigma} - (1+r_b)c(p_f^{OA})^{-\sigma}\right), \tag{69}$$

Solving for the optimal price delivers:

$$p_f^{OA} = \frac{1+r_b}{\tilde{\lambda}^{*}}\frac{\sigma}{\sigma-1}c. \tag{70}$$

Cash in Advance The Nash Product under Cash in Advance is given by:

$$NP^{CIA} = B^{CIA}\left(\tilde{\lambda}R - (1+r_b^{*})C\right), \tag{71}$$

with $B^{CIA} = \theta^{\theta}(1-\theta)^{1-\theta}\left(\frac{1+r_d}{1+r_b^{*}}\right)^{\theta}$. Plugging in the demand $q = p_f^{\sigma}A$ delivers:

$$NP^{CIA} = AB^{CIA}\left(\tilde{\lambda}(p_f^{CIA})^{1-\sigma} - (1+r_b^{*})c(p_f^{CIA})^{-\sigma}\right), \tag{72}$$

Solving for the optimal price delivers:

$$p_f^{CIA} = \frac{1+r_b^{*}}{\tilde{\lambda}}\frac{\sigma}{\sigma-1}c. \tag{73}$$

2.B.2 Solving the model with CES

We can plug in the CES revenues R and total cost C into the Nash Product for Open Account to get:

$$NP^{OA} = \theta^{\theta}(1-\theta)^{1-\theta}\frac{c^{1-\sigma}}{\sigma-1}A\left(\frac{\sigma}{\sigma-1}\right)^{-\sigma}\left(\tilde{\lambda}^{*}\right)^{\theta-1+\sigma}(1+r_b)^{1-\sigma} \tag{74}$$

For Cash in Advance, we get:

$$NP^{CIA} = \theta^{\theta}(1-\theta)^{1-\theta}\frac{c^{1-\sigma}}{\sigma-1}A\left(\frac{\sigma}{\sigma-1}\right)^{-\sigma}(1+r_d)^{\theta}(1+r_b^{*})^{-\theta+1-\sigma}\left(\tilde{\lambda}\right)^{\sigma} \tag{75}$$

Combining the two conditions, we get that Open Account is preferred over Cash in Advance if:

$$\left(\tilde{\lambda}^{*}\right)^{\theta-1+\sigma}(1+r_b)^{1-\sigma} - (1+r_d)^{\theta}(1+r_b^{*})^{-\theta+1-\sigma}\left(\tilde{\lambda}\right)^{\sigma} > 0 \tag{76}$$

Or, rewriting for interpretation:

$$\left(\tilde{\lambda}^{*}\right)^{\theta-1}\left(\tilde{\lambda}^{*}\right)^{\sigma}(1+r_b)^{1-\sigma} - \left(\frac{1+r_d}{1+r_b^{*}}\right)^{\theta}(1+r_b^{*})^{1-\sigma}\left(\tilde{\lambda}\right)^{\sigma} > 0 \tag{77}$$

Within a country, the equation simplifies to:

$$\left(\tilde{\lambda}\right)^{\theta-1} - \left(\frac{1+r_d}{1+r_b}\right)^{\theta} > 0, \tag{78}$$

which always holds when $r_b > r_d$. We can also take the derivative of equation (2.60) with respect to σ. This delivers:

$$\left(\tilde{\lambda}^{*}\right)^{\theta-1+\sigma}(1+r_b)^{1-\sigma}\left(\ln\tilde{\lambda}^{*} + \ln\left(\frac{1}{1+r_b}\right)\right) - (1+r_d)^{\theta}(1+r_b^{*})^{-\theta+1-\sigma}\left(\tilde{\lambda}\right)^{\sigma}\left(\ln\tilde{\lambda} + \ln\left(\frac{1}{1+r_b^{*}}\right)\right)$$

2.B.3 Trade Credit and Wholesale Markup

In this appendix we show that proposition 4 also holds for the markup in terms of the wholesale price that the seller charges to the buyer.

Note that the Nash products for the open account (equation 2.41) and cash-in-advance cases (equation 2.44) can be written in terms of the ratio of their respective prices to marginal costs replacing $\tilde{\lambda}R$ and $\tilde{\lambda}^{*}R$ with the optimal open account and cash-in-advance prices:

$$NP^{OA} = \left(\frac{1-\theta}{\theta}\right)^{1-\theta} (\tilde{\lambda}^{*})^{\theta} \left(P^{OA} - \frac{(1+r_b)}{\tilde{\lambda}^{*}} C^{OA}\right) \tag{79}$$

$$NP^{CIA} = \left(\frac{1-\theta}{\theta}\right)^{1-\theta} (1+r_d)^{\theta}(1+r_b^{*})^{1-\theta} \left(P^{CIA} - C^{CIA}\right) \tag{80}$$

Recall from section 2.6.4 (under the CES assumption) that the buyer-seller open account price can be expressed in terms of the buyer-seller cash-in-advance price as:

$$P^{OA} = \frac{1+r_b}{\tilde{\lambda}^{*}} \left(\frac{1+r_b}{1+r_b^{*}}\right)^{-\sigma} \left(\frac{\tilde{\lambda}}{\tilde{\lambda}^{*}}\right)^{-\sigma} P^{CIA} \tag{81}$$

In addition, assuming CES, we can derive:

$$C^{OA} = C^{CIA} \left(\frac{p_f^{OA}}{p_f^{CIA}}\right)^{-\sigma} = C^{CIA} \left(\frac{1+r_b}{1+r_b^{*}}\right)^{-\sigma} \left(\frac{\tilde{\lambda}}{\tilde{\lambda}^{*}}\right)^{-\sigma} \tag{82}$$

Combining equations (79) and (80) implies that a buyer-seller pair chooses open account if:

$$\left(\frac{1-\theta}{\theta}\right)^{1-\theta} \left[\left(\frac{1+r_b}{1+r_b^{*}}\right)^{-\sigma} \left(\frac{\tilde{\lambda}}{\tilde{\lambda}^{*}}\right)^{-\sigma} (\tilde{\lambda}^{*})^{\theta-1}(1+r_b) - (1+r_d)^{\theta}(1+r_b^{*})^{1-\theta}\right] (P^{CIA} - C^{CIA}) > 0$$

Which can be simplified to:

$$\left[(\tilde{\lambda}^{*})^{\theta-1+\sigma}(1+r_b)^{1-\sigma} - (1+r_d)^{\theta}(1+r_b^{*})^{-\theta+1-\sigma}(\tilde{\lambda})^{\sigma}\right] \left(\frac{P^{CIA}/Q^{CIA}}{c} - 1\right) > 0 \tag{83}$$

Deriving the markups: Open Account Under CES preferences, note that:

$$\frac{R^{OA}}{C^{OA}} = \frac{p_f^{OA}}{c} = \frac{1+r_b}{\tilde{\lambda}^*}\frac{\sigma}{\sigma-1} \tag{84}$$

From this, we can derive that:

$$\mu_W^{OA} \equiv \frac{P^{OA}/Q^{OA}}{c} = \frac{1+r_b}{\tilde{\lambda}^*}\left(1+\frac{\theta}{\sigma-1}\right) \tag{85}$$

Deriving the markups: Cash in Advance For CIA, note that:

$$\frac{R^{CIA}}{C^{CIA}} = \frac{p_f^{CIA}}{c} = \frac{1+r_b^*}{\tilde{\lambda}}\frac{\sigma}{\sigma-1} \tag{86}$$

Which delivers:

$$\mu_W^{CIA} \equiv \frac{P^{CIA}/Q^{CIA}}{c} = 1+\frac{\theta}{\sigma-1} \tag{87}$$

2.C Additional Details on Markups Estimation

2.C.1 Input Price Index

In this appendix we explain the construction of the firm-specific price index we construct to deflate materials' expenditure at the firm-level. This is necessary to avoid that the production function parameters we estimate are affected by input price bias (see De Loecker and Goldberg 2014 for details).

The construction of the firm-specific input price deflator involves five steps. First, we define the unit value of input j puchased by firm i in period t as $P_{ijt} = V_{ijt}/Q_{ijt}$, where V_{ijt} denotes input j value, and Q_{ijt} denotes the corresponding quantity purchased. Next, we calculate the (weighted) average unit value of input j across all firms purchasing the input at time t. Then, for each firm we compute the (log) price deviation from the (weighted) average for all the inputs purchased by the firm at time t. The next step involves averageing the resulting price deviations at the firm level, using inputs' expenditure as weight.[49] Finally, we anchor the resulting average firm-level input price deviation to aggregate (4-digit) input price deflators provided by the Chilean statistical agency. Therefore, the resulting input price index reflects both, changes in the aggregate input price inflation, as well as firm-level heterogeneity in the price paid by firms for their inputs.

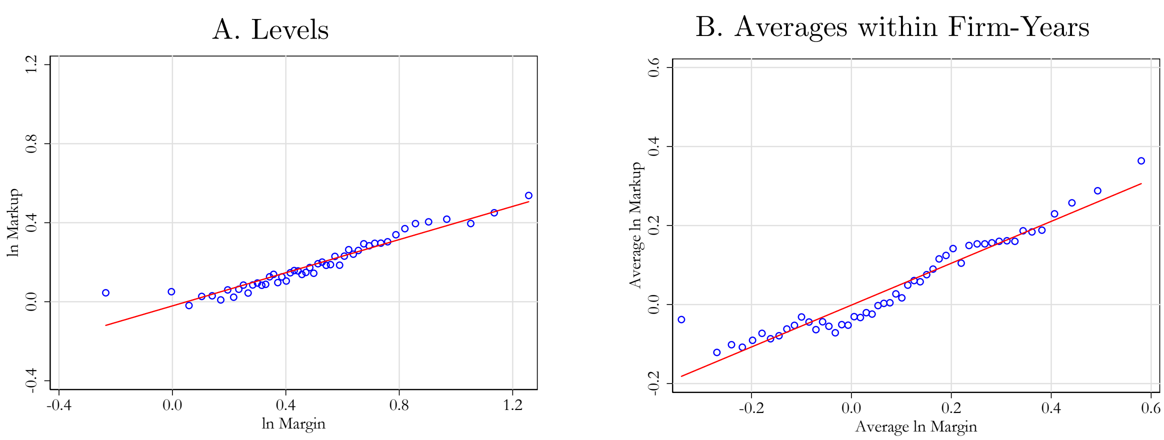
2.C.2 Markups and its relation with self-reported average margins

A unique feature of ENIA is that it provides information for the variable production cost per product defined as the product-specific sum of raw material costs and direct labor involved in production). Consequently, dividing sales by the reported total variable cost by the units produced of a given product yields the average product margin that we use as an alternative rough approximation for markups in the main text.

[49] Note that up to this point we have derived a unit-free input price index, that can be interpreted as the average firm-level input price deviation from the average. However, this price index will fail to detect aggregate changes in input prices.

Figure 2.C.1 plots binscatters diagram for firm-product markups and sales-cost margins (with products defined at the HS-8 level), for the raw data (left panel), and averaging across observations within firm-product pairs (right panel). Both figures control for country-year fixed effects (that is, the figure plots the within plant-product variation that we exploit empirically). There is a remarkable positive relationship between markups and reported margins, suggesting that our markup estimates yield sensible information about the profitability for the products produced by the firm. This lends strong support to the markup-based methodology for backing out marginal costs by De Loecker, Goldberg, Khandelwal, and Pavcnik (2016). In addition, there seems to be a tighter relationship between markups and margins when both variables are averaged within firm-products.[50] Consequently, in the main text we use firm-product average margins computed over all periods for as an alternative measure of markups (see Table 2.5).

Figure 2.C.1: Firm-Product level Markup and Sales-Cost Margin



Notes: The figure plots a binscatters diagram for firm-product markups and sales-cost margins. Both plots controls for country-year fixed effects.

For completeness, Table 2.D.2 replicates columns (4)-(6) of Table 2.5 using sales-cost

[50]One reason why both measures could be more correlated over longer periods of time is that the sales-cost margin measure relies on self-reported average variable cost. If managers measure product-level variable costs with error, then sales-cost margin may be a poorer approximation of markups in the short run. However, if managers does not make systematic mistakes when reporting average variable costs, the measurement error cancels out when averaging over longer periods.

margin in levels. As it can be seen, the positive relationship reported in the main text remains, but the magnitude and statistical significance of the coefficients are smaller than in the baseline analysis.

2.D Additional Results

2.D.1 Average Markups by 2-digit industries

This appendix performs a number of additional robustness checks. Table 2.D.1 presents the estimated markups at the level of 2-digit industries. Note that the average markups are somewhat lower than the average markups estimated for the entire manufacturing industry in Garcia-Marin and Voigtländer (2018).

Table 2.D.1: Estimated Markups

Product	Mean	Median	St. Deviation
Food and Beverages	1.344	1.2189	0.5711
Textiles	1.581	1.4491	0.6420
Apparel	1.267	1.2261	0.4649
Wood and Furniture	1.123	1.0070	0.4455
Paper	1.273	1.1214	0.5687
Basic Chemicals	1.389	1.2236	0.6555
Plastic and Rubber	1.241	1.0924	0.5305
Non-Metallic Manufactures	1.779	1.5555	0.8774
Metallic Manufactures	1.316	1.0241	0.7156
Machinery and Equipment	1.146	1.0102	0.4986
Total	1.318	1.178	0.583

Notes: This table reports the estimated markup by aggregate sector for the sample of exporting firms over the period 2003-2007 (see section 2.3.1 for details on the computation). Columns 1 displays the unweighted average markup.

Table 2.D.2: Sales-cost Margin (levels) and Open Account Share

	(1)	(2)	(3)
log(markup)	.0102**	.00902*	.00692
	(.00500)	(.00498)	(.00591)
ln(employment)	-.000829	-.00425	-.00141
	(.00418)	(.00428)	(.00494)
Firm-Destination FE	✓	✓	—
Year FE	—	✓	—
HS8 FE	—	✓	✓
Firm FE	—	—	✓
Destination-Year FE	—	—	✓
Observations	87,295	87,295	87,295
R^2	.662	.663	.368

Notes: The table replicates columns (4)-(6) of Table 2.5 using sales-cost margin in levels. All regressions are run at the firm-product-destination level (with products defined at the HS8-level). Open account shares are computed as the ratio of the FOB value of open account transactions to the FOB value of all export transactions over a year. Standard errors (in parentheses) are clustered at the firm-product level. Key: *** significant at 1%; ** 5%; * 10%.

Table 2.D.3: Translog Markups and Open Account Share: Heterogeneity

	(1)	(2)	(3)
log(markup)	-.0150	-.00642	-.0161
	(.0203)	(.0292)	(.0299)
ln(markup)$\times r_b^*$	.205*	.205*	.247**
	(.107)	(.107)	(.112)
ln(markup)$\times r_d$	—-	-.978	-.892
		(2.370)	(2.373)
ln(markup)$\times$ Law	—	—	.0251
			(.0161)
Firm-year FE	✓	✓	✓
HS8 FE	✓	✓	✓
Destination-Year FE	✓	✓	✓
Observations	91,291	91,291	91,291
R^2	.421	.421	.421

Notes: The table reports the coefficient estimates from equation (2.34). All regressions are run at the firm-product-destination level (with products defined at the HS8-level). Open account shares are computed as the ratio of the FOB value of open account transactions to the FOB value of all export transactions over a year. Markups are computed at the firm-product-year level (products are defined at the 8-digit HS level). Standard errors (in parentheses) are clustered at the destination-year level. Key: *** significant at 1%; ** 5%; * 10%.

Chapter 3

Quality Guarantee and Trade Credit. Evidence from Chilean Exporters

Santiago Andrés Justel, UCLA

What explains the provision and maturity of trade credit contracts? The existing literature has focused mainly on explaining the empirical regularity that firms consistently use trade credit, but has struggled to explain why one side of the market –sellers– systematically provide most of the credit. This paper develops a model where trade credit is used by sellers to signal product quality and documents empirical support for predictions of the model. In an equilibrium of the model, by offering products on credit, the producer is signaling that her products are of high quality. In addition, through the duration of credit, the seller provides a quality guarantee by allowing the buyer to certify the quality of the product before payment. The theory predicts a positive relationship between product quality, the likelihood of providing credit, and the maturity of trade credit. Furthermore, the model predicts positive correlations between credit maturity and other factors such as better legal institutions, product market competition , and difficulty of quality assessments. Using the universe of Chilean transaction-level customs data, I confirm these predictions. Finally, the paper considers the model's implications for recent policy changes in the U.S., France, and Chile to limit the maturity of trade credit.

3.1 Introduction

Trade credit (delayed payment) is widely used among firms domestically, and internationally[1], and is one of the primary sources of short-term financing for both small and large firms.[2] Despite its ubiquity and importance, there is not a clear understanding of the reasons that firms provide credit to each other when there is a financial sector that specializes in the provision of funding.

Most existing theories explain the use of trade credit as an efficient mechanism that helps to reduce a financial/transaction cost or to address some form of uncertainty. Although these theories are not mutually exclusive, some of their implications are at odds with the empirical evidence. For example, the financial motive is hard to square with the fact that small firms that have no financial advantage in credit provision - due to being more credit and liquidity constrained - commonly extend trade credit to large buyers who are not financially restricted.[3]

More importantly, all existing theories focus on the provision of trade credit (extensive margin), while being are silent on the maturity of said credit (intensive margin). The maturity of trade credit is a relevant dimension for many reasons. First, the number of days of credit can explain part of the financial constraints that a firm faces. Secondly, studying the different maturities can help to favor or disregard a particular theory of trade credit. For example, theories based on inventory costs or delayed-sales motive for trade credit suggest a trade credit maturity of similar duration to average inventory cycles, while observed trade credit periods are generally longer.[4]. Related to this, trade credit is used extensively in the

[1]According to Parlhem (2016), 97 percent of the transactions are conducted under trade credit. Internationally, Antras and Foley (2015) for a single US exporter, Demir and Javorcik (2018) Turkish data, Ahn (2011) Colombia and García-Marín, Justel, and Schmidt-Eisenlohr (2019) for Chilean exporters and importers, report that around 90% of international trade involves some form of delayed payment

[2]See Petersen and Rajan (1997) and Demirguc-Kunt and Maksimovic (2002)

[3]See Klapper, Laeven, and Rajan (2011), Justel (2019), McMillan and Woodruff (1999), and Marotta (2005) for evidence of size and trade credit

[4]In the sample of international transactions that I use, the average trade credit maturity is around 130 days for exports 80 days for imports. However, the average number of days of inventory in tradable sectors is between 50 to 80 days according to Chen, Frank, and Wu (2005) and Chen, Frank, and Wu (2007)

service sector, where inventories play no role.[5]

To address this gap in our understanding of trade credit, in this paper, I propose a theory where sellers use trade credit because it acts as a signal and a guarantee of the product's quality. The mechanism, similar to Long, Malitz, and Ravid (1993), is as follows: by offering products on credit, two things happen. On the one hand, through the provision of credit, the producer is signaling to a buyer that her products are of high quality since the producer is saying "pay me only if you are satisfied". Given this costly commitment, the buyer believes the product is of high quality. Besides, through the duration of the credit itself, the buyer is better able to certify the quality of the product before paying, allowing trade credit to also act as a quality guarantee.[6]

To formalize this idea, I propose a model where product quality is known to sellers but not known to buyers ex-ante, while buyers can (eventually) obtain a signal of product quality after delivery. Because of this, firms can use a combination of pricing and trade credit terms to signal the quality of their products, even when, from a strictly financial perspective, it is more costly for sellers to provide credit directly. The model predicts that high-quality goods are more likely to be traded under trade credit and also that higher quality goods will have longer maturities. Additionally, the theory also implies that countries with better legal institutions and industries with higher levels of competition will receive longer trade credit periods. Finally, the model predicts that products in which quality is hard to verify experience longer trade credit maturities.

These theoretical implications are tested using the universe of Chilean transaction-level trade data from the Chilean Customs Administration. This data set includes a trade credit maturity measure for each transaction, namely, the number of days in which a given purchase will be paid. To compute product quality, I will use two approaches. Following Khandelwal, Schott, and Wei (2013) and Fan, Li, and Yeaple (2015), I will infer product quality from prices and quantities directly from the data. Alternatively, due to endogeneity concerns

[5]In my sample, exported services have, on average, 80 days of trade credit.

[6]It is worth noting that this mechanism is analog to a money-back guarantee.

and measurement errors, I will focus on the Chilean wine industry. This specific sector has several measures that are commonly accepted as indicators of product quality (e.g., ratings, awards). In the empirical exercise, I will use these metrics as proxies of product quality.

My empirical results are consistent with the predictions of the model. In particular, I find that high-quality goods are 8% more likely to be traded under trade credit and high-quality products have, on average, 20 more days of trade credit.[7] Moreover, countries with better institutions have trade credit periods that are 5 days longer, firms that face higher competition provide 20 to 50 more days of trade credit, and products for which quality is harder to assess are sold with trade credit maturities that are 5 to 20 days longer.

Since many different data sets are used for studying trade credit, I check to see if previously documented regularities are present in the Chilean data. Following the existing literature, I compute the implied interest rate embedded in trade credit-mediated shipments and the effect of repeated transactions on the provision and maturity of trade credit. I obtain an implied annual interest rate of 25%, which is similar to other estimates. Also, I find that repeated interactions increase the likelihood of providing trade credit; however, repeated interaction does not significantly affect the maturity of the loan.

This paper contributes to the growing literature that tries to explain the motives for trade credit. These theories can be broadly grouped into financial, transaction costs, and asymmetric information models.[8] My model fits into the asymmetric information strand of the literature by expanding on the non-financial reasons for trade credit.

This paper also adds to the empirical evidence on trade credit. Most articles focus the empirical analysis on domestic firm-level data obtained through surveys e.g. Ng, J. Smith, and R. Smith (1999), using the Survey of Small Business Finances (SSBF) e.g Giannetti, Burkart, and Ellingsen (2011) and Petersen and Rajan (1997) or proprietary data e.g Cuñat (2006) and Klapper, Laeven, and Rajan (2011). In general, they find support for financial

[7] In the sample, 7% of transactions are paid in advance, while the rest is paid under some form of trade credit. Additionally, the average maturity for a trade credit contract is 130 days.

[8] Next section will provide more details and references for each approach.

and asymmetric information theories of trade credit.

My paper, through the use of international trade data, also contributes to growing literature on international trade finance. Authors like Schmidt-Eisenlohr (2013), Antras and Foley (2015), Hoefele, Schmidt-Eisenlohr, and Yu (2016), Niepmann and Schmidt-Eisenlohr (2017), and Ahn (2011) study how payment choices depend on country-specific characteristics such as financing cost, limited contract enforcement, capital controls and on industry complexity. Demir and Javorcik (2018) study the positive effect of competition on trade credit provision. García-Marín, Justel, and Schmidt-Eisenlohr (2019) propose and test a theory where trade credit is used to minimize transaction costs related to the presence of markups, and interest rate spreads. This paper includes some of the previous mechanisms, but it additionally studies the role of asymmetric information at the firm-product level and how it rationalizes the provision of trade credit and its maturity.

The model in this paper fits in the broader literature on quality signaling and the use of different types of signaling mechanisms. For example, firms can signal quality through: *prices* as in Wolinsky (1983), Bagwell and Riordan (1991), Tirole (1988), and Balachander and Srinivasan (1994); *advertising* like in Nelson (1974), Milgrom and Roberts (1986), and Bagwell and Ramey (1988); *warranties* as in Spence (1977), Lutz (1989), Dybvig and Lutz (1993), and Moorthy and Srinivasan (1995); *branding* e.g. Wernerfelt (1988), *the reputation of the retailer* as in Chu and Chu (1994). Authors have explored the use of trade credit also a signal for quality e.g. J. K. Smith (1987), Long, Malitz, and Ravid (1993), and Lee and Stowe (1993). The model presented in this paper builds on the existing theoretical literature by highlighting the maturity of the credit as a signal of quality, in addition to the offering of credit and interest rate terms. Most importantly, I offer micro-level evidence to support the novel mechanism suggested by the theory.

Given that it is costly for sellers to provide trade credit (accept delayed payment), and the near-ubiquity of this practice in international trade despite the credit constraints faced by many exporters, this paper contributes to the vast literature on credit constraints and international trade[9] since it provides a rationale for the existence of these restrictions.[10]

From a policymaking perspective, there is not much discussion about the importance of trade credit. However, the insights of this model are crucial since it implies that trade credit is not purely a financial tool. Therefore, trade credit facilitates trade for sellers, even when it is costly. This concern has policy relevance, as countries including the U.S., France, and Chile have recently implemented regulations setting a limit on the maturity of trade credit, based in part on the idea that long trade credit periods increase the financial burden for producers. My model predicts, however, that reducing trade credit maturity will reduce both the likelihood and volume of trade, a prediction consistent with recent empirical work in Breza and Liberman (2017).

In the next section, I present a review of the existing theories that explain the use of trade credit. In section 3, I develop the theoretical model of trade credit terms and establish the predictions of the model regarding correlates of trade credit maturity and product quality. In section 4, I introduce some definitions and the data that I will use to validate the predictions of the model. In section 5, I test empirically for the predictions of the model in the Chilean trade data. Finally, section 6 presents a discussion of the results and suggests avenues for further research.

3.2 Trade credit motives

The reasons why firms provide credit has been studied for more than 30 years. Because trade credit is one of the most important sources of short-term finance for a firm, one question commonly arises: What are the motives for a firm to lend to another firm, even in the presence of a developed financial sector? Four main theories explain the use and provision of trade credit.

[9]See Amiti and Weinstein (2011), Muûls (2015), Paravisini, Rappoport, Schnabl, and Wolfenzon (2014), Leibovici (2018), and Manova (2012) for some examples.

[10]For domestic trade, there are market solutions to obtain liquidity from trade credit transactions (e.g., invoice factoring). This short-term financing mechanism is not available for international transactions. Thus exporters need to rely on financial markets or own funds for short-term financing.

3.2.1 Financial Motives

This theory says that the producer may have an advantage over traditional lenders. The most basic one is, as in Schwartz (1974), that the producer has access to credit whereas the seller does not. Therefore the producer extends credit, in the form of trade credit, to the buyer. This financial advantage may come from the fact that the producer has better access to buyer's information (J. K. Smith 1987; Biais and Gollier 1997), has better ability to monitor the buyer (Burkart and Ellingsen 2004; Cuñat 2006) or has advantage in liquidating collateral over the financial sector (Mian and Smith Jr 1992; Maksimovic and Frank 2005).

3.2.2 Transaction Cost Motive

An alternative theory states that trade credit can reduce the transaction/inventory costs that can result from demand or delivery uncertainty as in Ferris (1981), Emery (1987), and Daripa and Nilsen (2011). The key mechanism is that in the presence of uncertainty on the delivery of goods, if the buyer pays them as they arrive, the buyer incurs in additional costs of money holdings. Alternatively, if there is uncertainty on the demand side, a buyer that pays earlier has a cash flow mismatch and bares the inventory costs (or missing sales). Therefore, trade credit might mitigate these problems since it helps to coordinate cash inflows and outflows.

3.2.3 Asymmetric Information Motives

Related, in part, to the financial motives is the theory that the producers have information that the buyers do not, in this case, the provision of trade credit may ease the "lemons problem." The asymmetry could be that the producer knows the quality of the product, and the seller does not (Long, Malitz, and Ravid 1993; Lee and Stowe 1993), or there are some "bad" firms that have incentives to default in the presence of limited commitment (Antras and Foley 2015; Schmidt-Eisenlohr 2013). In both cases, trade credit alleviates the problem since it acts as a contract enforcement mechanism.

3.2.4 Price Discrimination Motive

Because trade credit implies late payment of a product, it is natural to expect that cash prices are lower than trade credit prices.[11] Because of this, firms can use trade credit as a way of providing a menu of prices for the same good when buyers have different valuations or when some buyers are credit constraint therefore since they cannot take advantage of the discount, they are willing to pay higher prices to buy the product. Brennan, Maksimovics, and Zechner (1988) and Schwartz and Whitcomb (1979) are some examples of this theory.

From the empirical perspective, as surveyed in Cuñat and Garcia-Appendini (2012), the evidence seems to favor theories of information asymmetries and financial motives, but do not favor a particular mechanism. Giannetti, Burkart, and Ellingsen (2011) explicitly argue that the product quality theory finds limited support in the data.[12] One issue is that they conclude this using aggregate indicators of trade credit at the firm level (accounts receivable/payable) and indirect measures of quality/reputation (firm size). Alternatively, Pike, Cheng, Cravens, and Lamminmaki (2005), through a survey conducted to 700 firms in the US, UK, and Australia, explore the different theories and uses for trade credit. They also find support for models of information asymmetries; in particular, the authors find evidence for the product quality theory.

To the best of my knowledge, this is the first paper that studies empirically the direct relationship between trade credit and product quality at the transaction-level for a broad class of firms.

[11] This can be achieved implicitly through volume discounts and payment plans or explicitly offering discounts for early payment

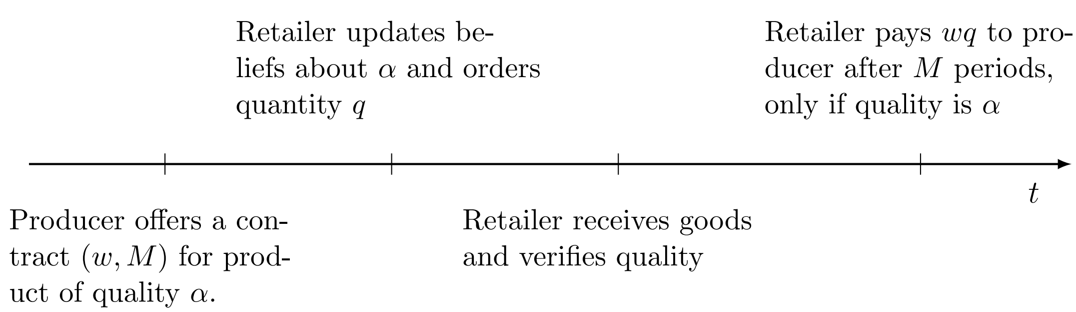
[12] Particularly, they say that according to this theory producers with established reputation should extend less trade credit since it is likely that they produce high-quality goods, whereas, in reality, large, well-known firms extend more trade credit.

3.3 Model

To motivate my empirical analysis and shed light on the mechanisms that drive my results, I consider a partial equilibrium model of payment choices in international trade in the spirit of Antras and Foley (2015) and Schmidt-Eisenlohr (2013). The key difference with these models is that I will include quality as a distinctive characteristic of the good. Moreover, the quality will not be observable. However, it can be verifiable over time. Thus trade credit, particularly the maturity of the credit, will have two functions: a signal of the quality of the good and a quality guarantee. A similar mechanism is proposed by J. K. Smith (1987) and Long, Malitz, and Ravid (1993).

In a nutshell, the model consists of a profit-maximizing producer (hereafter referred to as 'he') who supplies a variety s of a differentiated good to a profit-maximizing retailer (hereafter referred to as 'she'). The traded good will differ in its quality, which is known by the producer but is not observable immediately by the retailer. The producer offers a trade credit contract specifying a wholesale price $w > 0$ and a trade credit period $M \geq 0$, at which the retailer will pay back the total value of the transaction after M days. The timing of the decisions is as follows. The producer chooses the terms of the trade credit contract. The retailer chooses the quantity and the final price, taking the contract as given. Figure 3.1 describes sequence of events.

Figure 3.1: Sequence of events



3.3.1 Consumers

For tractability and clarity, I assume a specific linear demand system as in Foster, Haltiwanger, and Syverson (2008), Di Comite, Thisse, and Vandenbussche (2014), and Antoniades (2015)[13] for a particular product. This demand structure delivers simple analytical expressions. However, the main theoretical result does not rely on this particular demand since it also can be obtained through alternative demands systems.

I will assume the economy is endowed with a unit mass of consumers with the following preferences:

$$U = q_0 + \int_S \alpha_s q_s ds - \frac{\gamma}{2} \int_S [q_s]^2 \, ds - \frac{\eta}{2} \left[\int_S q_s ds \right]^2, \tag{3.1}$$

where q_0 and q_s correspond to the individual level consumption of the numeraire and the variety $s \in S$ respectively. As stressed out by Di Comite et al. (2014), the parameter $\alpha_s > 0$ reflects the vertical differentiation between varieties (with respect to the numeraire).[14] From now on, I will refer to α_s as quality.[15] The parameter $\gamma > 0$ indexes the degree of product differentiation between varieties. Finally, $\eta > 0$ represents the degree of substitutability between varieties. The inverse demand for a variety s implied by these preferences is given by

$$p_s = \alpha_s - \gamma q_s - \eta Q, \quad Q \equiv \int_S q_s ds. \tag{3.2}$$

Inverting (3.2), total quantity Q of differentiated variety can be defined as a function of aggregates as

$$Q = \left(\frac{N}{\gamma + \eta N} \right) [\bar{\alpha} - \bar{p}]$$

where $N \equiv \int_S ds$ is the number of varieties consumed, $\bar{\alpha} \equiv \frac{1}{N} \int_S \alpha_s ds$ and $\bar{p} \equiv \frac{1}{N} \int_S p_s ds$ are the average quality and price respectively.

[13] Although many other authors have used a similar specification. The cited authors explicitly include a demand shifter or 'quality' characteristic.

[14] To be precise, α_s reflects the willingness-to-pay for the first unit of variety of s.

[15] Antoniades (2015) assumes more structure on the preferences for quality, in any case, these preferences deliver a similar demand system.

3.3.2 Firms

There are two types of firms. Retailers and Producers. Retailers buy from Producers and sell directly to consumers. The trade credit decision comes from solving the problem between these two types of firms when product quality is not observable.

Retailers

Retailers are profit-maximizers that take the demand defined by (3.2), the quality of the product, and the cost of the product as given to choose retail prices and quantities.

For a given variety s, producers offered the following contract to the retailers: a wholesale price w and a trade credit maturity M, which means the retailer will pay the producer after M periods.[16] Taking this contract and the total quantity Q as given, the retailer buys amount q_s and sets a final price p_s such that profits are maximized. Additionally, following Antras and Foley (2015) and Schmidt-Eisenlohr (2013), I will assume that in every period, the retailer can face a liquidity shock such that if this shock is realized the retailer exits the market with zero profits. This liquidity shock will be modeled as a Poisson process with a rate of δ^*. Therefore, in a trade credit contract with a period of M, the probability of staying in the market is $e^{-\delta^* M}$. Finally, I will assume that there is no strategic default, in other words, in the absence of a liquidity shock, if the retailer bought and received a quality α product, she will honor the contract (w, M).

In the absence of additional costs, the retailer's expected profits as a function of quantity for a given quality α_s are defined as

$$\Pi^R(q_s|\alpha_s, w, M) = e^{-\delta^* M}\left(p_s - we^{-r^* M}\right)q_s = e^{-\delta^* M}\left(\alpha_s - \gamma q_s - \eta Q - we^{-r^* M}\right)q_s \tag{3.3}$$

where I substituted the final price by the expression obtained in (3.2) and r^* is the interest rate relevant for the retailer. Notice that, for simplicity, I assumed that the retailer sells all

[16] w and M depend on the variety s, but I omitted the sub-index for clarity purposes.

the goods at the beginning of the period, but pays back to the producer after M periods. Naturally, the demand for variety s is obtained maximizing (3.3), thus final price, demand for variety s and total profits as functions of quality are defined by[17]

$$p_s\left(w, M|\alpha_s\right) = \tfrac{\alpha_s-\eta Q+we^{-r^*M}}{2} \tag{3.4}$$

$$q_s\left(w, M|\alpha_s\right) = \tfrac{\alpha_s-\eta Q-we^{-r^*M}}{2\gamma} \tag{3.5}$$

$$\Pi_s^R\left(w, M|\alpha_s\right) = \tfrac{e^{-\delta^*M}}{\gamma}\left[\tfrac{\alpha_s-\eta Q-we^{-r^*M}}{2}\right]^2. \tag{3.6}$$

As expected, prices and quantities are increasing in quality, prices (quantities) are increasing (decreasing) in the wholesale prices, but most importantly, since trade credit decreases the present value of the payment, it effectively decreases (increases) the price (quantity).

Producers

Similarly, producers, who know the quality of their products, take the demand from the retailer as given and set wholesale prices and trade credit to maximize expected profits.

In particular, producers of a variety s maximize their profits using the demand from the retailer given by (3.5). A producer of variety s will have a marginal cost of c_s and no additional costs. Thus, a producer of variety s of quality α_s has expected profits of

$$\Pi^P(w, M|\alpha_s) = \left(we^{-(r+\delta^*)M} - c_s\right)\left(\frac{\alpha_s - \eta Q - we^{-r^*M}}{2\gamma}\right). \tag{3.7}$$

Where r is the interest rate relevant for the producer and δ^*, again, is the liquidity shock rate of the retailer. The assumption is that if the retailer exits the market, she defaults on her contract. When taking the model to the data, I will assume that δ^* is a country characteristic. Notice that δ^* is analogous to the inclusion of imperfect contracting friction, as in Antras and Foley (2015) and Schmidt-Eisenlohr (2013), since it captures the likelihood of the retailer honoring the contract that depends, among other things, on the destination

[17]Notice that the shock plays no role in the price and quantity. It affects only the profits.

country legal institutions.

3.3.3 Equilibrium

To characterize the equilibrium, I will examine the perfect information benchmark and conclude that in this framework, trade credit will not be provided unless there are financial incentives. However, in the asymmetric-information equilibrium, trade credit will be provided as a signal for product quality, acting effectively as a quality guarantee, even in the case that it is not financially efficient to provide it.

Perfect information contract

Under the *symmetric-information* setting, where quality α_s is known by the retailer. The producer solves:

$$\max_{w,M\geq 0} \Pi^P(w, M|\alpha_s) \tag{3.8}$$

Thus, under perfect information, wholesale prices, quantities and producer expected profits as a function of trade credit maturity and quality are defined by

$$w(M|\alpha_s) = \frac{(\alpha_s-\eta Q)e^{r^*M}+c_s e^{(r+\delta^*)M}}{2} \tag{3.9}$$

$$q_s(M|\alpha_s) = \frac{\alpha_s-\eta Q-c_s e^{(r+\delta^*-r^*)M}}{4\gamma} \tag{3.10}$$

$$\Pi^P_s(M|\alpha_s) = \frac{e^{-(r+\delta^*-r^*)M}}{2\gamma}\left[\frac{\alpha_s-\eta Q-c_s e^{(r+\delta^*-r^*)M}}{2}\right]^2 \tag{3.11}$$

Lemma 1. ***(Symmetric-information benchmark)*** *In the symmetric-information contract, if $r+\delta^* > r^*$ then the optimal provision of trade credit will be $M = 0$ and the wholesale* *prices, quantities and producer profits are*

$$w(\alpha_s) = \tfrac{\alpha_s - \eta Q + c_s}{2} \tag{3.12}$$

$$q_s(\alpha_s) = \tfrac{\alpha_s - \eta Q - c_s}{4\gamma} \tag{3.13}$$

$$\Pi_s^P(\alpha_s) = \tfrac{1}{2\gamma}\left[\tfrac{\alpha_s - \eta Q - c_s}{2}\right]^2 \tag{3.14}$$

The proof is direct from (3.11). This lemma states that, under perfect information, the motive for the provision (and maturity) of trade credit is purely financial. Therefore, if the producer has no financial incentives, due to the fact of credit being more expensive or riskier compared to the credit that the retailer can obtain, he will not provide trade credit to the retailer.

The condition $r + \delta^* > r^*$ resembles the condition for the provision of trade credit over prepayment obtained by Antras and Foley (2015) and Schmidt-Eisenlohr (2013).[18]

Asymmetric-information contract

I turn to the case where the producer has private information about the quality of the variety he produces. I will focus my attention on the separating equilibrium since I want to study the case where prices and trade credit maturity may include information about the quality of the product.[19]

To ease exposition, I will assume that each variety s can have two possible qualities, high or low. Suppressing the index s, this means that $\alpha \in \{\alpha^L, \alpha^H\}$. Additionally, as it is standard in this literature, I will assume that producing a high-quality variety is more costly than producing a low-quality one, then $c^H > c^L$. Defining $\Delta\alpha \equiv \alpha^H - \alpha^L$ and $\Delta c \equiv c^H - c^L$, I assume that $\Delta\alpha > \Delta c$. This last assumption implies that, under perfect information, profits are increasing in quality or, equivalently, larger firms produce higher quality products.

[18]In their models, given the mismatch between delivery and payment, they also include the possibility of default for the producer, so they also include a home country-risk variable

[19]In the appendix 3.A.2 I explore the pooling equilibrium and conditions for its existence.

To isolate the role of quality signaling of the trade credit, I will assume that $r + \delta^* > r^*$, that is, producers have no financial incentives to provide trade credit. Finally, the critical assumption of the model is that after delivery but before payment, the retailer may receive a signal of the quality of the product. For simplicity, this signal will be a *perfect bad news* signal, which means a single signal arrival conclusively indicates low quality. This signal will be a Poisson process with an arrival rate of μ. Moreover, if the retailer receives this signal, but she did not buy a low-quality product, she will default on her contract, and these products become worthless. Intuitively, trade credit maturity acts as product quality guarantee, since a more extended credit period implies a higher chance to verify the actual quality of the product.

Proposition 6. *Under asymmetric-information about product quality, a separating equilibrium will be characterized by the low-quality producer offering the symmetric-information contract* $(w^L, 0)$ *with* $w^L \equiv \frac{\alpha^L - \eta Q + c^L}{2}$*. Whereas the high-quality producer deviates and offers a contract* (w, M) *such that* $w > w^H$ *and* $M \geq 0$*, where* w^H *is the wholesale price of the high-quality product under perfect information.*

The proof of the existence of a separating equilibrium has been extensively discussed in the literature, see for example Wolinsky (1983), Bagwell (1992), and Overgaard (1993), where firms signal product quality exclusively through prices. Because through the provision of trade credit, I am just broadening the space of signals, the separating equilibrium still exists. The key assumption needed for the existence of the separating equilibrium is the single-crossing property, guaranteed in this case by the assumption $\Delta\alpha > \Delta c$. Intuitively, if both types of producers offer their symmetric-information contract, the high-quality producer does not have the incentive to deviate to the low-quality contract since it implies a lower wholesale price ($w^H > w^L$) and he pays a higher marginal cost.

On the other hand, the low-quality producer has incentives to mimic the high-quality firm since he will receive higher prices and pays the lower marginal cost. Therefore high-quality producer will pay the signaling cost through higher prices and trade credit (which is costly) to separate themselves from the low-quality firm. In that case, the low-quality producer will offer the full information price.

As it has been stated in the literature, there are many separating equilibria. The one that survives the Intuitive Criterion, as defined by Cho and Kreps (1987), corresponds to the most efficient separating equilibrium[20] characterized by the solution of the following problem

$$\begin{aligned} &\max_{w,M\geq 0} && \left(we^{-(r+\delta^*)M} - c^H\right) q\left(w, M|\alpha^H\right) \\ &\text{subject to} && \left(e^{-\mu M} we^{-(r+\delta^*)M} - c^L\right) q\left(w, M|\alpha^H\right) \leq \Pi^L \end{aligned} \tag{3.15}$$

Where the $q\left(w, M|\alpha^H\right)$ is given by (3.5), Π^L represents the profits of the low quality producer under the symmetric-information equilibrium and the constraint corresponds to the local incentive compatibility, where wholesale prices and trade credit maturity deter the low quality firm from mimicking the high-quality producer. The first part of this restriction correspond to the expected revenue of the low quality producer when he tries to pass as a high-quality firm and he is not caught, the second part is the total production cost $c^L q$. The following proposition describes the optimal trade credit contract.

Proposition 7. *Under asymmetric-information about product quality, the contract (w, M) that satisfies the Intuitive Criterion is the most efficient separating equilibrium that solves (3.15). Moreover, for μ large enough, this contract $(w, M > 0)$ solves the following system:*

$$w = \frac{\left(\alpha^H - \eta Q\right)e^{r^* M} + c^H e^{(r+\delta^*)M}}{2} + \frac{r+\delta^* - r^*}{2\mu}(c^H - c^L \mathrm{e}^{\mu M})e^{(r+\delta^*)M} \tag{3.16}$$

$$\Pi^L = \left(e^{-\mu M} we^{-(r+\delta^*)M} - c^L\right) q\left(w, M|\alpha^H\right) \tag{3.17}$$

Otherwise, the optimal contract is defined by the system:

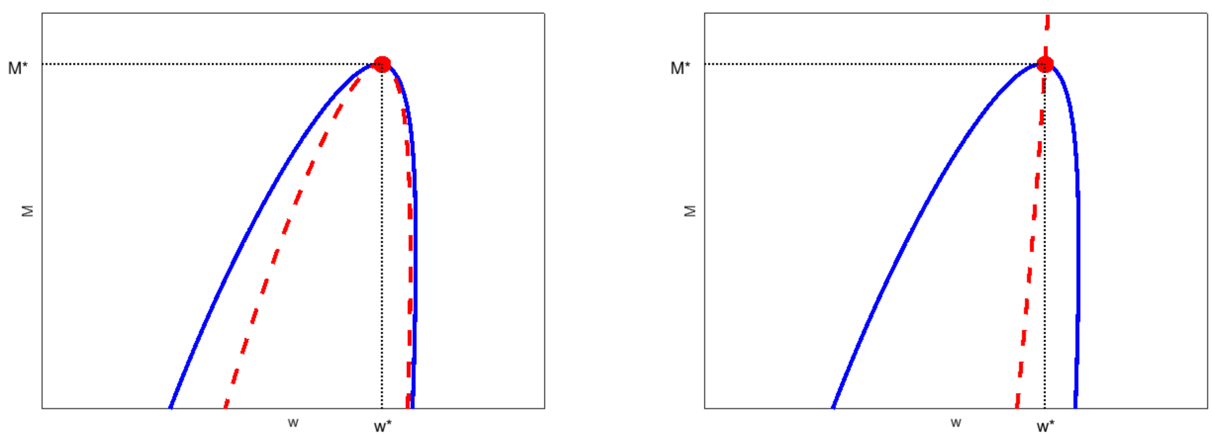
$$M = 0 \tag{3.18}$$

$$\Pi^L = \left(w - c^L\right) q\left(w, 0|\alpha^H\right) \tag{3.19}$$

[20]Most efficient equilibrium in the sense that producer maximizes profits using the lowest price/trade credit maturity possible. Both are costly signals.

Proof can be found in the Appendix. Proposition 7 characterizes the optimal contract and shows that the parameter μ is essential for the use of trade credit. If the rate of the verification of quality is low, there is no use in the provision of trade credit, since it is an expensive and ineffective signal. Therefore quality will be signaled only through prices. As long as μ is large enough, the high-quality producer will use wholesale prices and trade credit maturity to signal the quality of the product. Figure 3.2 shows a graphical representation of the optimal contract as the solution of the maximization problem or as the solution of the non-linear system of equations described in proposition 7.

Figure 3.2: Characterization of optimal contract.



(a) Solution given by (3.15)

(b) Solution characterized by Proposition 7

Note: Solid line corresponds to the IC constraint. Dashed line, on the left panel, corresponds to the objective function in (3.15). On the right panel dashed line corresponds to equation (3.16) in Proposition 7

3.3.4 Increasing quality

Proposition 7 delivers the fact that high-quality goods are more likely to be traded under trade credit. Now the question is, what happens in the case of multiple quality levels?

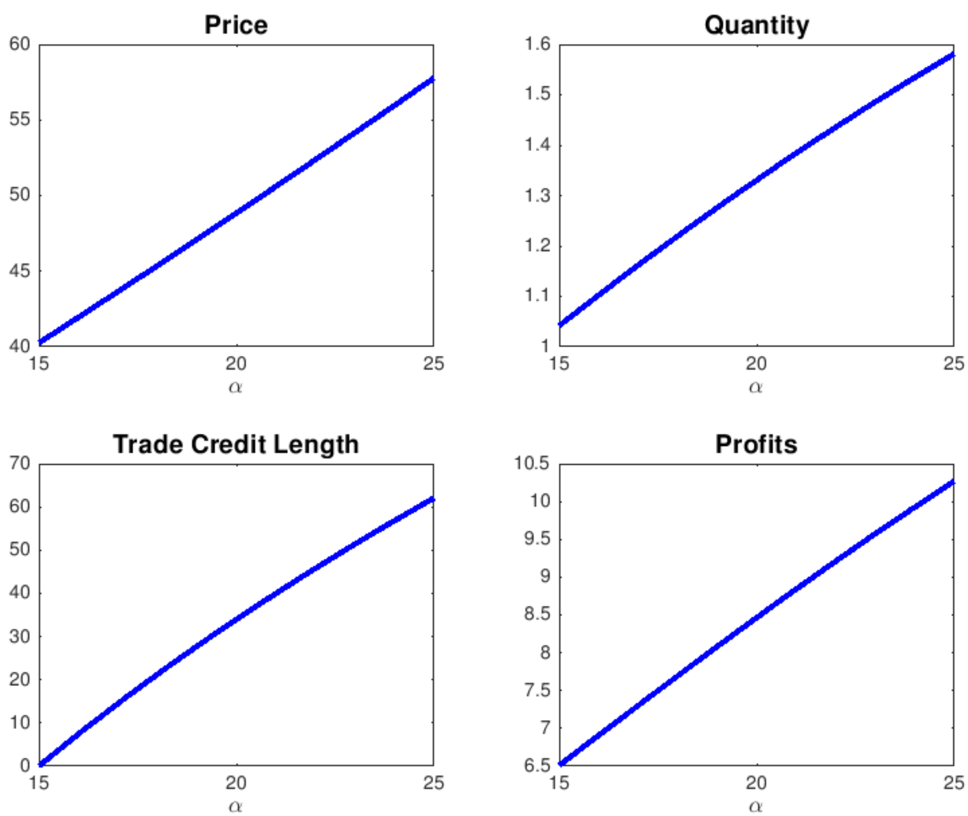
To easily answer this question, I conduct a comparative static analysis by increasing α^H and c^H, while still assuming $\Delta\alpha > \Delta c$.[21] This delivers the following result:

[21] Alternatively, one can assume a set of different quality levels and their corresponding costs. The problem

Proposition 8. *In the most efficient separating, the wholesale price w and trade credit maturity M increase with quality.*

Although a formal proof in a simplified version of the model is provided in Appendix 3.A.3, this result is intuitive. Increasing quality makes mimicking more attractive for low-quality firms, thus both signals: wholesale price and trade credit maturity must increase to deter this behavior. Figure 3.3 exemplifies the contract and some of the outcomes as α^H and c^H increase.

Figure 3.3: Contract as a function of quality



with this is that the most efficient contract becomes increasingly complicated since all the IC constraints must be checked.

3.3.5 Predictions

This model, and its extension, delivers 3 testable predictions. First, from the optimal contract, propositions 7 and 8 state the main testable result of this paper.

Prediction 1. *High-quality firms are more likely to extend trade credit. Moreover, higher quality goods are traded under longer trade credit periods.*

The mechanism is very intuitive. Trade credit acts as a quality guarantee. Delaying the payment decision gives itself an enforcement tool to the retailer. In this model, a contract does not consist only in the delivery of a product, which a short trade credit period can also enforce. A contract describes the delivery of a product of a certain quality, and since quality is hard to asses, longer maturities are needed to enforce the contract.

Secondly, because of the presence of financial motives (r, r^* and δ^*) and other demand factors (ηQ), this model also delivers the following predictions with respect to the relationship between trade credit provision and market-specific characteristics.

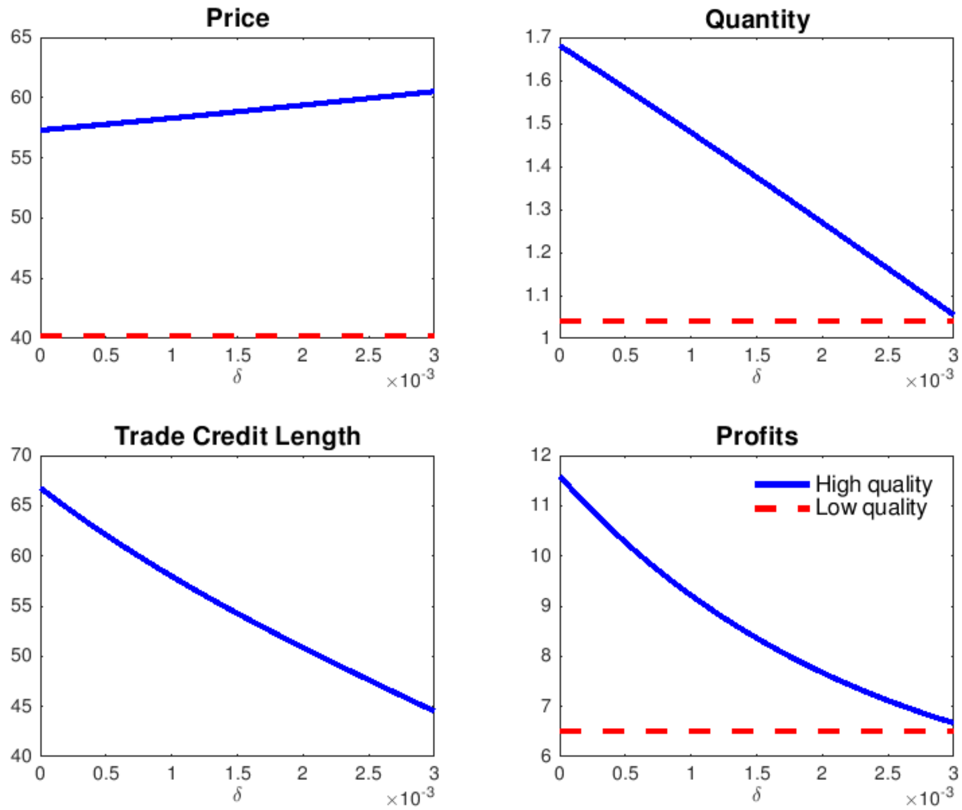
Prediction 2. *Trade credit maturity will be longer in countries with:*

1. *better institutions (low δ^*)*

2. *higher level of competition (high ηQ)*

The first part of the prediction is intuitive. δ^* captures an exogenous default rate on the contract. Better legal institutions imply that this default probability is lower, the credit becomes cheaper. Then if δ^* is lower, the transaction under credit will be more likely to be paid, reducing the cost of providing trade credit. Therefore the producer has more incentives to use trade credit as a signal for quality. Figure 3.4 shows the effect of δ^* over some of the outcomes of the model. As risk increases, the price also increases. Consequently, quantities and profits decrease.

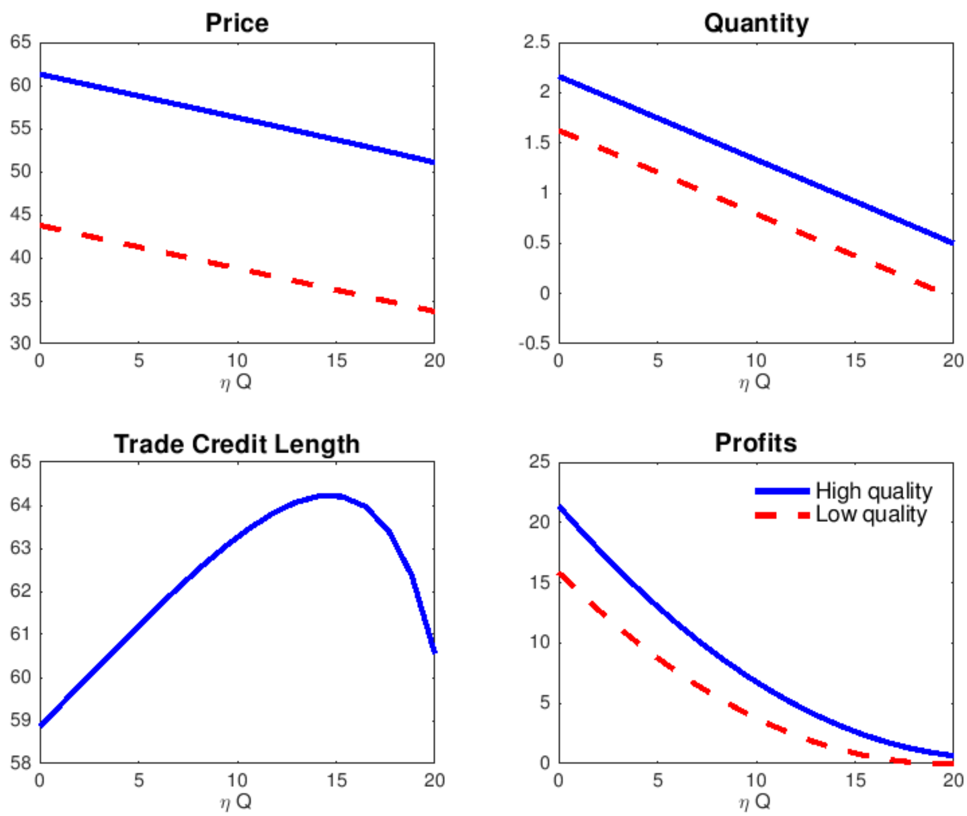
Figure 3.4: Contract as a function of δ



The competition effect is not as intuitive because, as competition increases, two things happen: low-quality firm's profits decreases and expected revenue when deviating also decreases. While the former tightens the incentive compatibility constraint, the latter relaxes the restriction. The effect that dominates depends on the parametrization, as Appendix 3.A.3 shows, under very mild conditions, namely, a significant difference between high quality and low quality or a high rate of μ, the overall effect will be non-monotonic. For small enough levels of competition, the low-quality profit effect dominates. Thus the IC constraint becomes tighter, forcing an increase in the maturity of trade credit. On the other hand, for high levels of competition, the low-quality profits are so low that the revenue effect dominates. The IC constraint is relaxed, decreasing the incentives for more extended trade credit periods.

This relationship and the corresponding intuition can be seen in figure 3.5, particular in the last panel, where profits for low and high-quality firms are plotted. When low-quality firm profits are low (close to 0) is when the relationship of trade credit maturity and competition changes direction. The overall positive relationship between competition and trade credit provision is documented by Fisman and Raturi (2004), Hyndman and Serio (2010), and Singh (2017). Moreover, the inverted U-shape resembles the one that Hyndman and Serio (2010) find empirically. In their paper, they find that the provision of trade credit and competition has an inverted U-shape.

Figure 3.5: Contract as a function of ηQ



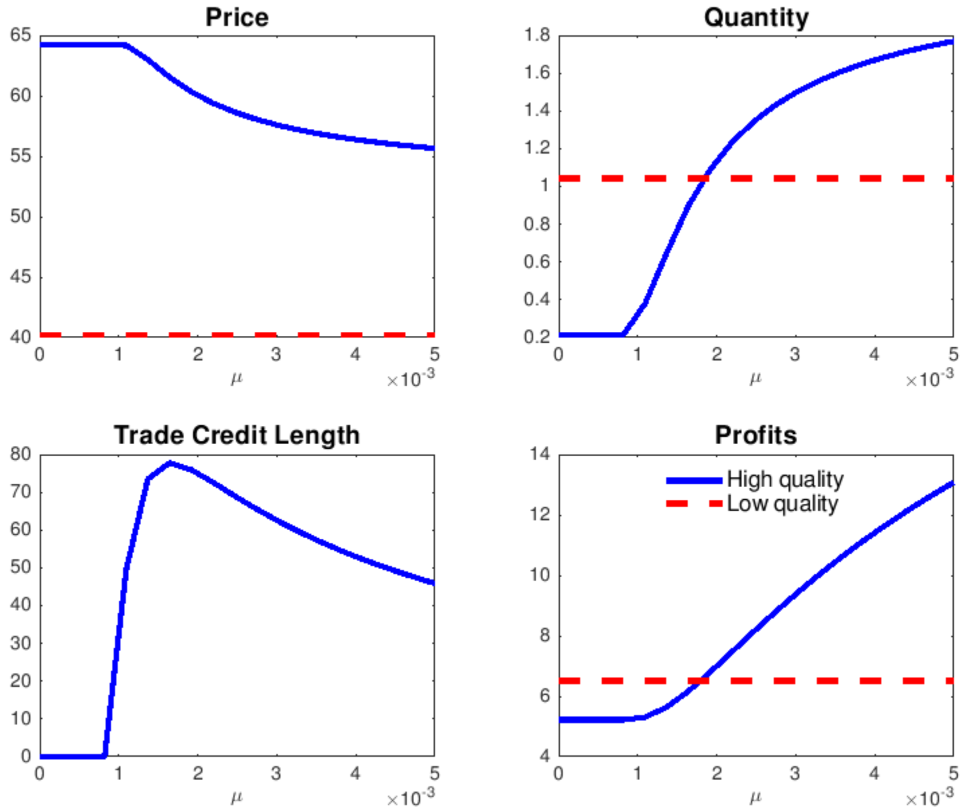
Finally, one of the key aspects of this model is the quality verification dimension, captured by the parameter μ. Therefore I can test an additional prediction.

Prediction 3. *Trade credit maturity will be longer for products where quality is hard to* *assess (low μ).*

Since μ is the rate at which the importer receives the signal that verifies the quality of the product. A product with a higher μ is akin to a product in which quality is easy to establish, therefore if a product's quality is easy to asses, a shorter trade credit period will be necessary to verify the quality and deter the low-quality firm from deviating. Figure 3.6 describes this intuition. As previously discussed, for a very low μ, trade credit will not be used as a signal. Therefore the separating equilibrium will be sustained only through prices, which in turn implies that high-quality firm has lower profits compared to the low-quality firm. Notice that the prediction of a negative relationship between μ and trade credit length is true only when high-quality firm profits are greater than the low-quality firm, which is not an implausible assumption.[22]

[22] This outcome can be obtained in an extension where there are two sets of firms: one with access only to low-quality technology and the other one with access to both high and low-quality technology. Under this setting, the separating equilibrium exists, thus high and low quality will simultaneously be offered, only if high-quality profits are greater than low quality.

Figure 3.6: Contract as a function of μ



3.4 Payment Contracts and Data

To test the predictions of the model, I will use a detailed transaction-level from Chilean customs. This data set that allows me to study the relationship between quality and trade credit includes information on destination/origin, prices, quantities, and the type of payment contract that was used in a given transaction.

3.4.1 Payment contracts

Before describing the data, it might be useful to outline the type of payment contracts used in international trade. Following the literature, these contracts are Open Account, Cash-in-Advance, Letter of Credit, Documentary Collection, and a Two-Part agreement that combines any two of the previous ones.

An *Open Account* (OA) transaction in the trade finance literature, corresponds to an operation that the importer pays directly to the exporter after shipment/arrival of the product. This type of arrangement is the closest to a standard trade credit contract.

The opposite in terms of payment risk is the case where the importer pays to the exporter before shipment(arrival) of the goods. This arrangement is known as *Cash-in-Advance* (CIA).

Somewhere in the middle, in terms of risk, is the case where banks can intermediate through documentation that acts as a payment guarantee. One of these mechanisms is called *Letter of Credit* (LC). In this arrangement, the importer agrees to pay the transaction to his bank, said bank issues a letter to the exporter's bank that serves as a guarantee for payments under specified conditions.[23] After these conditions are met, the exporter's bank releases the payment to the exporter. Exporter's bank collects the money from the importer's bank and finally, the importer pays to his bank.[24]

Similar to the letter of credit, there is the *Documentary Collection* (DC). The critical distinction is that under LC, the bank is required to give the money to the exporter if the conditions are satified; in other words, payment is almost guaranteed. Under DC, there is no guarantee. The importer can decide not to honor the contract, hence the exporter will not receive the payment.[25]

The final type of contract is a combination of any of the previous four in the form of a two-part contract (e.g., 20% CIA, 80% OA). Figure 3.7 summarizes the types of arrangements and their relationship with risk.

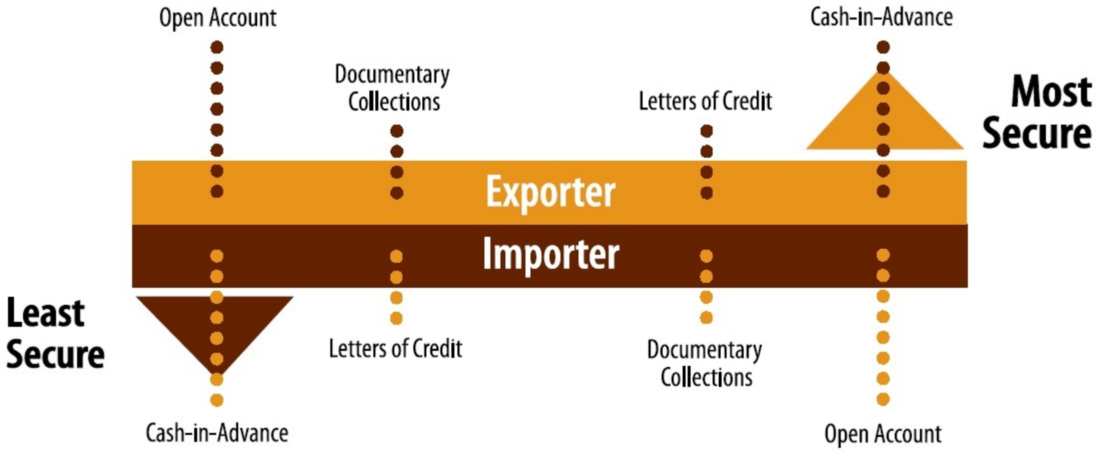
As figure 3.7 shows and what the literature has stressed, there is a tension in how risk is shared between parties, particularly the default risk. CIA is the safest for the exporter, since he will receive the payment early, but is the riskiest for the importer since the exporter

[23]These conditions consist of the presentation of documents by the exporter to his bank. The documentation needed can vary but consists of: bill of lading, certificate of origin, commercial invoice, inspection documents, among others.

[24]The importer pays a fee to his bank for this service. Between fixed charges and a percentage of the value, these fees may vary between 1 and 10% of the total amount of the transaction.

[25]In this case, the importer also pays a fee to the bank, but since the bank faces almost no risk, the fees are lower. They correspond to 1% or less of the face value of the transaction.

Figure 3.7: Payment methods and risk



might not deliver the goods. Similarly, OA is the safest for the importer, but most uncertain for the exporter since the importer might not pay the agreed transfer, even after the arrival of the products.

Notice that, aside from the risk-sharing problem, financially speaking OA, LC and DC contracts are very similar in the sense that the exporter will receive the payment after the arrival of the goods. Hence all these arrangements look like a standard trade credit contract. Therefore, the credit period plays an important role, since longer maturities imply that the exporter must fund his working capital through the financial system for a more extended period, incurring additional costs.

3.4.2 Data

My empirical analysis that relates trade credit and product quality is mainly based on transaction-level data provided by the Chilean Customs Agency.

The data set, available for exports and imports, includes standard information such as the firm's tax number, 8-digit HS product code, destination/origin country, value, quantities, etc. There are two unique features of these data sets. First, for both exports and imports, the data sets include information about the trade finance contract for each shipment. In particular, if the transaction was paid in advance (CIA), post-shipment (OA), with some bank documentation (LC/DC)[26], through a two-part contract or if the purchase actually was not paid. Secondly, and key for my analysis, both data sets also include a measure that captures how many days later will the exporter (importer) collect (make) the payment. In the case of exporters, they need to report to Customs the exact date that they will receive the payment (or last payment in the case of a two-part contract). Similarly, importers need to report directly the number of days in which they will make the payment (or final payment). This data is available for 2009 to 2017 for the case of exports and 2007 to 2017 for imports.

Table 3.1: Shares by type of contract

	Exports		Imports	
	Transaction	FOB	Transaction	FOB
OA	87.1	83.7	66.6	75.9
LC/DC	2.0	12.7	5.6	9.3
CIA	6.9	3.0	25.2	13.3
Two-part	0.4	0.2	0.6	1.0
No payment	3.6	0.4	2.0	0.5

Note: Column Transaction computes average weighting by transaction. Column FOB, weighting by value.

As table 3.1 shows, the most predominant form of trade finance is OA, with around 85% of exports (weighted by transaction or FOB value) and 70% of imports being paid after arrival with no intermediation. Moreover, trade credit, in the sense of late payment (OA+LC/DC), accounts for 90% of the exports and more than 70% of imports. Also, it is essential to note that the two-part contracts are almost non-existent, accounting for less than 1% of the trade flows.[27]

In the case of exports, I proxy the maturity of each type of contract as the difference between the reported payment date and the shipment date. For imports, I use the direct report of the number of days. Table 3.2 shows the number of days on average that each contract is paid. In the case of exports, trade credit transactions are paid after 4 and a half

[26]From the data, I cannot disentangle if a transaction was paid using DC or LC.
[27]Among the two-part agreements, the most frequent is the 50% CIA, 50% OA.

Table 3.2: Average number of days by contract

	Exports		Imports	
	Transaction	FOB	Transaction	FOB
OA	132.7	148.7	73.8	78.0
LC/DC	159.6	197.4	133.1	131.3
CIA	-20.6	-28.3	-	-
Two-part	84.1	110.8	75.8	115.9

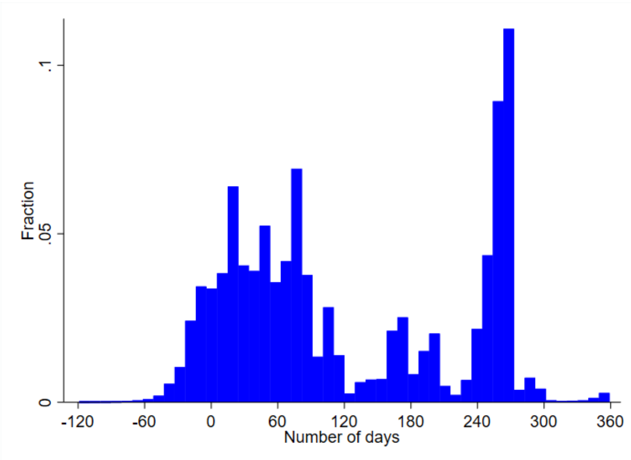
Note: Column Transaction computes average weighting by transaction. Column FOB, weighting by value. In the case of Imports, when transaction is CIA, importers report 0 days.

months on average. Trade credit related to imports is shorter, with an average maturity of 2 and a half months. Notice that regardless of LC/DC being considerably safer options compared to an OA contract, LC/DC contracts have similar credit periods, in the case of exports, or considerably longer, for imports. This last point supports the fact that from a financial perspective, both contracts are akin to trade credit since both imply a late payment. Finally, it is worth noting that this proxy for trade credit period implies that on average transactions under CIA are paid 20 days before shipping, which is considerably lower than the number of days provided as trade credit.[28] Figure 3.8 shows the full distribution of maturities. By construction, the credit period for exporters is continuous, although spikes can be seen close to 30, 60, 90, 120 days, as it is standard in trade finance practice. For imports, since the number of days is directly reported, there are clear modes at 0 days (CIA), then 30, 60, 90, and 120 days.

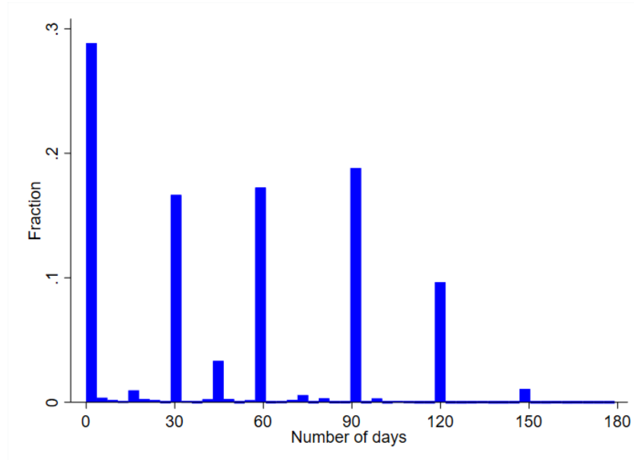
I complement this data set with data from the Chilean Tax Agency. This additional firm-level data set includes measures of size (number of workers, equity, tax bracket based on total sales), age, and industry at the 6-digit level.

[28]This difference comes from the fact that I do not have the actual date of production/invoicing of a given product. So this number of days should be considered a lower bound since the traded good was produced before the shipment date. As a matter of fact, for a subsample of the data set, I can obtain the actual date of the invoice, and for those cases, the average number of days of prepayment is between -1 and 0. Moreover, this sample has clear modes at 0, 30, 60 and 270 days. Appendix 3.C.1 shows the comparison for both the actual trade credit and the proxy measure I use throughout the paper.

Figure 3.8: Distribution of number of days



(a) Exports



(b) Imports

Quality

To test the main mechanism of the model and its implications, a key measure needed is product quality. For this, I will use two approaches. First, following Khandelwal, Schott, and Wei (2013) and Fan, Li, and Yeaple (2015), I will infer quality from prices and quantities. Alternatively, due to endogeneity and measurement error concerns in the quality estimation, I will focus on the wine industry and use wine ratings and other measures as proxies for product quality. To estimate quality using prices and quantities Khandelwal, Schott, and Wei (2013) assume a CES demand system that includes quality as a demand shifter, the demand for a product of a given quality α is defined as:

$$q = p^{-\sigma} \alpha^{\eta} A$$

where q is quantity, p reflects price, σ is the demand elasticity, and A represents a combination of the price index and aggregate expenditure in country d. Taking logs and rearranging

$$\eta \log \alpha = \log q + \sigma \log p + \log A$$

Then assuming a value for σ, $\eta \log \alpha$ can be estimated as the residual of

$$\log q_{fpdt} + \sigma \log p_{fpdt} = \gamma_{dt} + \gamma_p + \varepsilon_{fpdt}. \tag{3.20}$$

Where γ_{dt} is a set of destination×year fixed effects that control for A and γ_p are product fixed effects included since prices and quantities are not necessarily comparable across product categories. Thus quality can be proxied by $\widehat{\eta \log \alpha} \equiv \hat{\varepsilon}$. The value of the demand elasticity σ is key, and following the literature, I will use common values in the trade literature $\sigma = \{5, 10\}$, also I will use the values estimated at the product level by Broda and Weinstein (2006), thus $\sigma = \sigma_p$ in this case. Finally, when estimating quality with this methodology, I follow the literature[29] and restrict the sample to differentiated goods as defined by Rauch (1999) since these products by definition are the ones who might display quality differentiation. In contrast, homogeneous goods do not.

The previous measure of quality has several issues, particularly measurement error since it is based on estimation. Therefore I will use an alternative approach to test the robustness of my results. Specifically, I will take an objective measure of quality in a single industry, wine.

The wine industry in Chile is not a large sector in Chile. It contributes 0.5% of the GDP and represents around 3% of total Chilean exports (7% of exports in manufacturing). However, it is a significant industry internationally. In 2018, Chile was the 5th largest wine exporter, representing 5.3% of world wine exports.[30] The key aspect of using the wine industry is the existence of several magazines and websites that publish objective and comparable ratings for wine. To use this information, I will exploit an additional feature of my data set, for each transaction, there is a variable that describes, in plain text, the product that is being traded. In the case of wine, from this variable, I will extract information that

[29] See Khandelwal (2010), for example

[30] For reference, France, Italy and Spain, the 1st, 2nd and 3rd largest wine exporters respectively, amount to almost 30, 20 and 10% of worldwide wine exports.

identifies the particular wine, for example, winery, brand if it exists, grape/blend[31], vintage and additional keywords e.g. *Reserve*, *Organic*. Using this information, I web-scrapped ratings, retail price, and awards for each wine. Additionally, from the description, I extract text that indicates if the wine is bulk wine, that obviously is not rated, but potentially may signal a low-quality wine.

Given these approaches, I will focus my empirical analysis using only data for exports. Table 3.3, in the following page, shows some summary statistics for the full sample and the restricted ones. As expected, the sample is very skewed in terms of value per transaction and exporter size (measured by total exports or by number of workers)

[31]Some examples of grape are Cabernet Sauvignon, Merlot, Pinot Noir, etc. With 'blend' I mean a mix of grapes.

Table 3.3: Summary stats

	Full Sample				Differentiated goods				Wine			
	Mean	Median	1 decile	9 decile	Mean	Median	1 decile	9 decile	Mean	Median	1 decile	9 decile
FOB ($1000s)	62.3	5.8	0.2	58.4	20.4	3.2	0.1	50.3	9.2	3.9	0.8	22.8
Trade credit (days)	122.3	82	1	269	94.8	66	-8	260	104.8	80	38	254
Firms per year	7900.7	7707	7458	8403	5010.2	4917	4623	5553	377.0	361	340	427
Tot Exp per firm-year ($1000s)	8535.4	87.3	3.6	4481.4	1178.8	29	2.1	1071.9	4664.1	359.5	14.7	9739
Workers per firm-year	206.7	31	2	434	242.9	40	3	499	175.8	26	1	355
Dest. per firm-year	26.4	18	3	56	11.7	9	2	25	59.1	53	17	123
Trans. per firm-year	6408.6	2192	119	17147	4904.4	989	45	10165	10838.1	3586	461	39141
Prods. per firm-dest-year	11.1	4	1	27	13.9	5	1	37	-	-	-	-
Observations	9821302				2621197				1728119			

Table 3.4 describes additional statistics for the wine sample, particularly, statistics related to quality. In general, the exported wine is of high quality. This fact is shown by the high average price per bottle, high average rating, or the large share of the wine exports that have an award.

It is worth to point out the fact that, according to Rauch (1999), wine is not a differentiated good. Thus both restricted samples are completely independent.[32]

Table 3.4: Additional statistics wine-quality

	Mean	Median	p1	p99
Price (FOB)	5.00	3.33	0.77	35.30
Final Price ($ per bottle)	25.71	10	4	141
Rating (0-100)	87.35	87	83	93
Award	0.43	0	0	1
Bulk	0.03	0	0	1

3.5 Empirical analysis

The primary purpose of this empirical section is to study the use of trade credit as a quality guarantee and to assess the validity of the proposed model. To do that, I will test the following hypotheses: (1) High-quality products are more likely to be traded under trade credit (Prediction 1). (2) Higher quality goods will be purchased with more extended trade credit periods (Prediction 1). (3) Trade credit period will be longer in countries with better legal institutions and markets with a high level of competition (Prediction 2); Trade credit will be shorter for products that quality is easier to verify (Prediction 3).

To capture the relationship between trade credit provision and quality described in Prediction 1, I will estimate the following equation:

$$I(CIA_{fpdt} = 1) = \beta \text{quality}_{fpdt} + \gamma_{pdt} + \varepsilon_{fpdt}, \tag{3.21}$$

[32]Several authors have indicated that one of the problems with Rauch (1999) is related to the classification of agricultural products, see Bernini, González, Hallak, and Vicondoa (2018) for a discussion.

where $I(CIA_{fpdt} = 1)$ is a dummy variable that is one if a transaction from firm f of product p to destination d at period t was paid under *cash-in-advance*, quality_{fpdt} is a measure of quality and γ_{pdt} are product×destination×year fixed effects to control for unobserved heterogeneity potentially correlated with product quality, for example demand shocks. Similarly, for the second part of Prediction 1 that relates trade credit maturity and quality, I will estimate the following equation:

$$M_{fpdt} = \beta \text{quality}_{fpdt} + \gamma_{pdt} + \varepsilon_{fpdt}, \tag{3.22}$$

where M_{fpdt} is the maturity in days of the trade credit extended by firm f, when selling product p to destination d in period t.

To test Predictions 2 and 3 , I will estimate a general equation of the form

$$M_{fpdt} = \beta X + \boldsymbol{\nu}'\boldsymbol{Z} + \boldsymbol{\gamma} + \varepsilon_{fpdt}, \tag{3.23}$$

where X will be the relevant destination-specific measure for institutional quality, firm-destination-product specific measure of competition and product-specific measure of quality verifiability. $\boldsymbol{Z}$ represents a set of additional observables and $\boldsymbol{\gamma}$ are a set of fixed effects to control for unobservables.

3.5.1 Relationship between quality measures

Before moving to the main results, it is worthwhile to show that all the measures for product quality that I will use are correlated, as expected.

As previously stated, I will use two approaches to measure product quality. I start measuring quality from the data set as the residual of (3.20). Along these lines, for robustness, I will proxy product quality by firm size, as proposed by Kugler and Verhoogen (2011) and Manova and Zhang (2012).

Table 3.5 shows the cross-correlations between these measures of quality. All of these metrics are positively related, as has been well documented in the literature.

Table 3.5: Cross correlation over quality measures

	α ($\sigma = 5$)	α ($\sigma = 10$)	α ($\sigma = \sigma_p$)	$\log N$	log Equity	log tot Exp	Sales bracket	Age
α ($\sigma = 5$)	1							
α ($\sigma = 10$)	0.95	1						
α ($\sigma = \sigma_p$)	0.46	0.40	1					
$\log N$	0.17	0.10	0.15	1				
log Equity	0.24	0.16	0.17	0.75	1			
log tot Exp	0.31	0.17	0.21	0.65	0.66	1		
Sales bracket	0.18	0.08	0.13	0.71	0.80	0.67	1	
Age	0.11	0.05	0.08	0.38	0.41	0.34	0.42	1

Note: α is the estimated quality with the value of σ indicated. σ_p is the product-specific elasticity estimated by Broda and Weinstein (2006). $\log N$ is corresponds to the log of employment, $\log$ tot Exp is the log of the value of total of exports for a firm in a given year. Sales bracket is the classification of size based on total annual sales according to the Chilean tax agency. All correlations are significant at 1%.

Alternatively, for the case of wine, I will use additional measures for quality, such as wine rating, final price, awarded wine, and bulk wine. Table 3.6 shows the cross-correlation between these variables. As expected, high quality, measured as the residual of equation (3.20), is positively correlated with size, high ratings, high final price, and the likelihood of having an award. Also, not surprisingly, high quality is negatively correlated with bulk wine. The rest of the correlations have the expected sign, except for the final price and the fact that the wine earned an award. This relationship has a negative correlation, although very low.

Table 3.6: Cross correlation over quality measures - Wine

	$\alpha(\sigma = 5)$	$\alpha(\sigma = \sigma_p)$	$\log N$	log Equity	log tot Exp	Sales bracket	Age	Rating	log final price	Award	Bulk
$\alpha(\sigma = 5)$	1										
$\alpha(\sigma = \sigma_p)$	0.64	1									
$\log N$	0.44	0.42	1								
log Equity	0.44	0.39	0.86	1							
log tot Exp	0.46	0.49	0.83	0.81	1						
Sales bracket	0.42	0.41	0.80	0.73	0.87	1					
Age	0.25	0.22	0.48	0.48	0.49	0.52	1				
Rating	0.21	0.18	0.28	0.31	0.28	0.13	0.11	1			
log final price	0.18	0.14	0.20	0.23	0.19	0.08	0.02	0.84	1		
Award	0.16	0.13	0.23	0.21	0.20	0.19	0.11	0.02	-0.02	1	
Bulk	-0.06	-0.03	-0.10	-0.08	-0.04	-0.02	-0.03	.	.	-0.16	1

Note: α is the estimated quality with the value of σ indicated. In the case of wine, Broda and Weinstein (2006) estimated $\sigma_p = 2.2$. $\log N$ is a measure of size and corresponds to the log of employment log tot Exp is the log of the value of total of exports for a firm in a given year. Sales bracket is the classification of size based on total annual sales according to the Chilean tax agency. Award and Bulk are dummy variables with value 1 if wine earned an award or if it is a bulk wine. All correlations are significant at 1%.

3.5.2 Results

Results are consistent with the predictions of the model. In particular, I find that high-quality goods more likely to be traded under trade credit, and high-quality goods have longer maturities. Additionally, trade credit will be longer in countries with better legal institutions, in markets where firms face more competition and for products for which quality is hard to verify.

Probability of extending trade credit

Table 3.7 shows one of the main empirical results of this paper, the estimation of equation (3.21), that relates quality and the likelihood of a transaction being paid in advance. The first column is the regression using size, measured by log employment, as a proxy for quality under the full sample, the following columns use the estimated quality under different elasticities, for those cases, I use the restricted sample of differentiated goods. To ease the comparison among results, row $\Delta I(CIA = 1)$ indicates the marginal change in the probability of *cash-in-advance* evaluating the independent variable from percentile 1 to percentile 99 (akin to going from low quality to high quality). Table 3.7 shows that higher quality products are, on average, 8 percent less likely to be traded under trade credit.

Table 3.7: Quality and Likelihood of Trade Credit

Dep. var	$I(CIA = 1)$			
	$\log N$	$\sigma = 5$	$\sigma = 10$	$\sigma = \sigma_p$
Quality	-0.008***	-0.005***	-0.002***	-0.002***
	(0.001)	(0.001)	(0.000)	(0.000)
Obs.	9181870	2576753	2576753	2285070
R^2	.439	.549	.548	.553
$\Delta I(CIA = 1)$	-0.072	-0.120	-0.094	-0.056

Note: All regressions include product×destination×year fixed effects. σ_p is the product-specific elasticity estimated by Broda and Weinstein (2006). $\log N$ is corresponds to the log of employment. Robust standard errors are clustered at firm × destination level. *, **, *** represent significance at 10, 5 and 1% respectively.

Since the relationship between size and the probability of providing trade credit is well documented[33], perhaps the correlation between quality and trade credit is capturing the relationship of size and trade credit. To tackle this issue, I estimate equation (3.21) controlling by firm size. Table 3.8 indicates that the relationship between quality and provision of trade credit still exists, although its impact is cut by half.

Table 3.8: Quality and Likelihood of Trade Credit and Firm Size

Dep. var	$I(CIA = 1)$		
	$\sigma = 5$	$\sigma = 10$	$\sigma = \sigma_p$
Quality	-0.002**	-0.001*	-0.001**
	(0.001)	(0.000)	(0.000)
$\log N$	-0.019***	-0.019***	-0.020***
	(0.003)	(0.003)	(0.004)
Obs.	2436580	2436580	2158721
R^2	.539	.538	.545
$\Delta I(CIA = 1)$	-0.059	-0.044	-0.026

Note: All regressions include product×destination×year fixed effects. σ_p is the product-specific elasticity estimated by Broda and Weinstein (2006). $\log N$ is corresponds to the log of employment. Robust standard errors are clustered at firm × destination level. *, **, *** represent significance at 10, 5 and 1% respectively.

Now I proceed to estimate equation (3.21) for the case of wine. Since, in this case, the sample is one product, I include a set of grape×destination×year fixed effects to control potential differences in types of wine. According to table 3.9, the results are similar, and they present the expected negative relationship between quality and the probability of pre-payment. Two important comments. First, the negative correlation measured by ratings and final prices exists but is very weak because the rated wines are already of high quality. Therefore there is not sufficient variance. Secondly and surprisingly, bulk wine seems to be traded through trade credit, which is counter-intuitive with the proposed mechanism, under the natural assumption that bulk wine is of lower quality compared to bottled wine. This result comes from the fact that bulk wine, although low quality, is traded in large volumes[34]. Thus each transaction of bulk wine becomes important for both exporter and importer. Ta-

[33] See Justel (2019) for example

[34] Average volume of non-bulk wine is 4 tons, whereas average bulk wine is 52 tons

ble **??** in the Appendix shows that once controlling for the volume of each transaction, the rest of coefficients remain the same, but the one for bulk wine becomes positive, significative and with a similar magnitude compared to the other ones.

Table 3.9: Quality and Likelihood of Trade Credit - Wine

Dep. var	$I(CIA=1)$								
	$\sigma=\sigma_p$	$\sigma=5$	$\log N$	Rating	Avg Rating	log price	log Avg price	Award	Bulk
Quality	-0.010***	-0.004***	-0.008***	-0.001	-0.001*	-0.001	-0.001	-0.009***	-0.007**
	(0.001)	(0.001)	(0.001)	(0.000)	(0.000)	(0.001)	(0.001)	(0.002)	(0.003)
Obs	1661139	1663495	1540375	937489	950493	787027	1201204	1664188	1664188
R^2	.118	.112	.12	.129	.132	.153	.113	.111	.11
$\Delta I(CIA=1)$	-0.089	-0.041	-0.063	-0.006	-0.009	-0.003	-0.003	-0.009	-0.007

Note: Broda and Weinstein (2006) estimated $\sigma_p = 2.2$ for wine. Rating and price correspond to the rating and final price of a particular wine-vintage. Avg Rating and Avg price are respective average ratings and final prices for a wine over vintages. Award and Bulk are dummy variables with value 1 if wine earned an award or if it is a bulk wine. All regressions include grape×destination×year fixed effects. Robust standard errors are clustered at firm × destination level. *, **, *** represent significance at 10, 5 and 1% respectively.

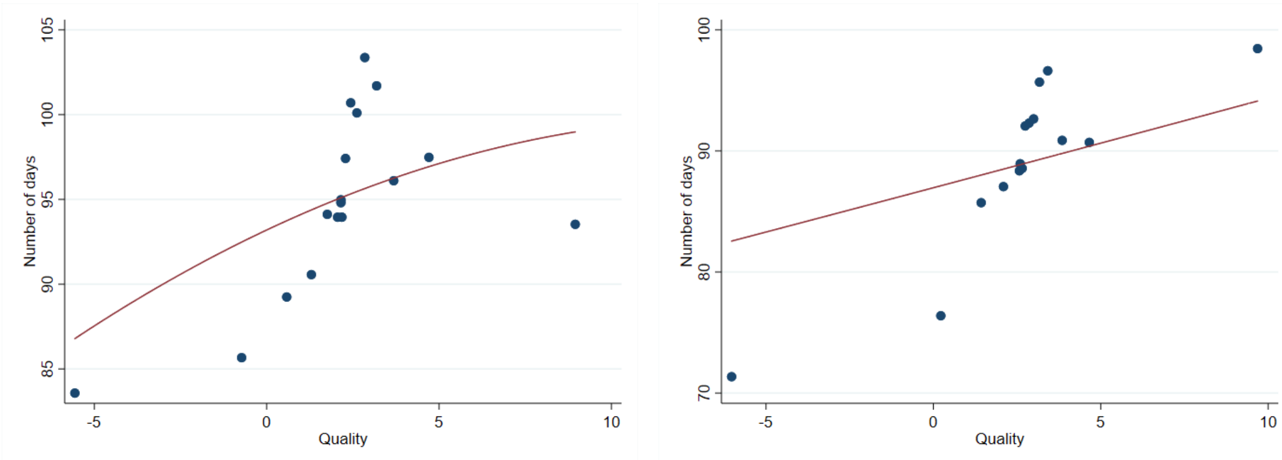
Trade credit maturity

The previous section emphasized the relationship between the discrete choice of providing trade credit and product quality. One of the advantages of my data set is the fact that I can study the provision of trade credit as a continuum (how many days before/after arrival, the importer will pay). In this section, I show the second main result of this paper, namely the positive relationship between product quality and trade credit maturity. Figure 3.C.2 shows a graphic representation of equation (3.22). It shows the relationship between product quality and the number of days provided as trade credit.

The results of estimating equation (3.22) are summarized in table 3.10. Once again, to ease comparison, row ΔM describes the difference in the number of days when evaluating the independent variable from the 1st percentile to the 99th. On average, high-quality goods have 20 days longer trade credit compared to low-quality products.

In the previous estimation, I used transactions conducted under trade credit and prepayment and without additional firm controls, which might be an important omitted variable. The results are robust when controlling for these potential issues. Table 3.11 summarizes

Figure 3.9: Trade credit maturity and quality



(a) $\sigma = 5$ (b) $\sigma = \sigma_p$

Note: Both figures are binned scatter plots of number of days of trade credit vs. quality measured as the residual of (3.20) demeaned by product×destination×year. Left panel estimates quality using demand elasticity of 5 and right panel using the demand elasticity estimated by Broda and Weinstein (2006)

Table 3.10: Trade credit maturity and quality

Dep. var	M			
	$\log N$	$\sigma = 5$	$\sigma = 10$	$\sigma = \sigma_p$
Quality	3.164***	0.851***	0.209**	0.665***
	(0.766)	(0.224)	(0.104)	(0.142)
Obs.	8849859	2401104	2401104	2125504
R^2	.553	.599	.598	.621
ΔM	26.972	21.046	10.740	21.283

Note: All regressions include product×destination×year fixed effects. σ_p is the product-specific elasticity estimated by Broda and Weinstein (2006). $\log N$ is corresponds to the log of employment. Robust standard errors are clustered at firm × destination level. *, **, *** represent significance at 10, 5 and 1% respectively.

several robustness checks. The first panel restricts the sample to exclude transactions conducted under *cash-in-advance*. The middle panel uses the full sample, trade credit, and CIA transactions, but controls for firm size. The final panel is a combination of a restricted sample and firm size. In general, results remain similar quantitatively.

Now, I turn back the attention to the wine exports sample. As before, figure 3.10 shows

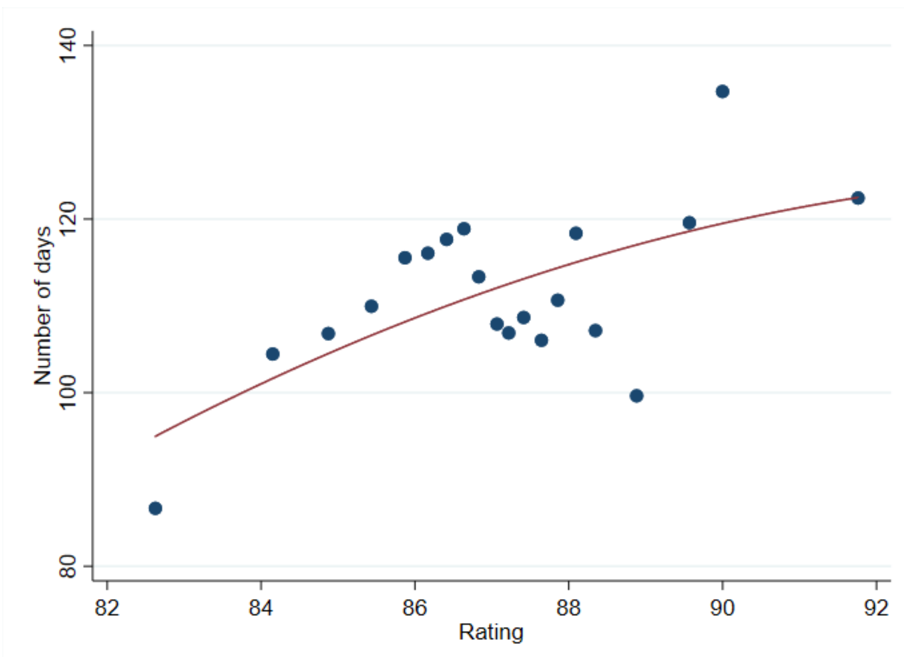
Table 3.11: Trade credit maturity and quality - Robustness checks

	$M > 0$				Size			$M > 0$ + Size		
	$\log N$	$\sigma = 5$	$\sigma = 10$	$\sigma = \sigma_p$	$\sigma = 5$	$\sigma = 10$	$\sigma = \sigma_p$	$\sigma = 5$	$\sigma = 10$	$\sigma = \sigma_p$
Quality	2.698**	0.873**	0.291*	0.996**	0.515*	0.105	0.631**	0.736**	0.278*	0.999**
	(0.76)	(0.287)	(0.133)	(0.246)	(0.237)	(0.111)	(0.158)	(0.286)	(0.133)	(0.245)
$\log N$	-	-	-	-	5.717**	5.802**	4.069**	4.499**	4.579**	2.552*
					(1.025)	(1.032)	(1.013)	(1.091)	(1.098)	(1.086)
Obs.	8052086	2065979	2065979	1812642	2269693	2269693	2007557	1990042	1990042	1748159
R^2	0.565	0.611	0.611	0.64	0.604	0.604	0.626	0.618	0.618	0.646
ΔM	23.162	20.322	13.766	29.293	12.255	5.205	19.379	16.866	12.981	29.429

Note: All regressions include product×destination×year fixed effects. Panel 1 restricts the sample to transactions with positive trade credit ($M > 0$), panel 2 is the full sample, but includes log total employment, final panel restricts sample to transactions under trade credit and controlling for firm size. Robust standard errors are clustered at firm × destination level. *, **, *** represent significance at 10, 5 and 1% respectively.

graphically the relationship between trade credit maturity and wine quality, measured by its rating.

Figure 3.10: Trade credit maturity and wine rating



Note: Figure corresponds to binned scatter plot of number of days of trade credit vs. average Rating demeaned by grape×destination×year.

Table 3.12 reports the results from estimating equation (3.22) with the additional measures of quality. All the coefficients are significant. Moreover, these coefficients imply that high-quality goods have 30 more of trade credit. Tables ??-3.B.4 in the Appendix show additional robustness checks with restricted sample and the inclusion of firm size as controls. The main result still holds.

Table 3.12: Trade credit maturity and quality - Wine

Dep var	M								
	$\sigma = \sigma_p$	$\sigma = 5$	$\log N$	Rating	Avg Rating	log price	log Avg price	Award	Bulk
Quality	6.772***	4.024**	6.292***	2.266**	3.013***	5.721**	7.783***	15.759***	-18.798***
	(2.388)	(1.938)	(2.021)	(1.118)	(1.076)	(2.645)	(2.185)	(3.308)	(6.536)
Obs.	1652425	1654780	1531896	933345	946440	784245	1196461	1655466	1655466
R^2	.177	.167	.186	.184	.198	.261	.187	.168	.16
ΔM	57.495	36.556	48.911	22.658	30.129	20.381	25.709	15.759	-18.798

Note: Rating and price corresponds to the rating and final price of a particular wine-vintage. Avg Rating and Avg price are respective average ratings and final prices for a wine over vintages. Award and Bulk are dummy variables with value 1 if wine earned an award or if it is a bulk wine. All regressions include grape×destination×year fixed effects. Robust standard errors are clustered at firm × destination level. *, **, *** represent significance at 10, 5 and 1% respectively.

Trade credit maturity, institutions, and competition

In this section, I test the additional predictions regarding trade credit maturity, quality of institutions, and competition. It has been shown in the literature the effect of some of these variables on the discrete decision of providing trade credit or not, so now I exploit the extensive margin, namely the number days of trade credit.

First, I start testing the first part of prediction 2: the positive relationship between trade credit maturity and better legal institutions. To verify that, I estimate the following regression.

$$M_{fpdt} = \beta X_{dt} + \boldsymbol{\nu' Z_{dt}} + \gamma_{fpt} + \varepsilon_{fpdt}, \tag{3.24}$$

where X_{dt} will be a country-specific measure of institutional quality. Z_{dt} will be additional country-specific controls such as log GDP and log distance. Finally, I include firm×product×year fixed effects to capture supply shocks (e.g., productivity and learning). To measure institutional quality, I will use several measures; most of them already used in related literature.

First, I will use the most basic metric, GDP per capita; this measure has been extensively related to legal institutions.[35] Additionally, I will use the rule of law index constructed by the World Bank. This measure captures the perceptions of the extent to which agents have confidence in and abide by the rules of society, the quality of contract enforcement, property rights, the police, and the courts.[36] Finally, I will include measures used in Antras and Foley (2015) such as: Common Law dummy, a variable that captures if a given country has common law legal origin as opposed to other legal frameworks such as civil, German, socialist law; enforceability of contracts, a measured constructed by Knack and Keefer (1995) that captures the degree to which contracts are honored; law and order index that captures the integrity of legal system from the Country Risk Guide and it is obtained from Djankov, La Porta, Lopez-de-Silanes, and Shleifer (2003).

Table 3.13 shows the results of estimating (3.25) for different measures of institutional quality. As can be seen, institutional quality is positively related to trade credit maturity. On average, for a given firm, selling a product, better institutions implies five days longer trade credit on average. This low number, compared to the quality-related estimations, favors the theory that contract enforcement seems to matter for the decision of providing trade credit more than the extension of the credit itself.

The first panel on table 3.13 corresponds to the full sample. The second panel excludes CIA contracts. It is worth to note that distance seems to play an important role as expected. This fact is indirectly captured in the theory since far destinations will receive their products later. Therefore these importers need more time to asses the quality of these products. This intuition is corroborated using an alternative specification where I additionally control by transportation mode. Table 3.B.7 in the Appendix describes that compared to waterborne transportation, arguably slower, air and ground transportation imply a shorter trade credit period.[37]

[35] e.g. Acemoglu, Johnson, and Robinson (2001)

[36] More details in Kaufmann, Kraay, and Mastruzzi (2011)

[37] I additionally, control for the trade quantity since it might be the case that air and ground transportation have volume constraints. In general, results do not change.

Table 3.13: Quality and Institutions

	Full Sample					$M > 0$				
	$\log GDP_{PC}$	Rule of Law	Common Law	Enforce	Law&Order	$\log GDP_{PC}$	Rule of Law	Common Law	Enforce	Law&Order
Institution	3.123***	3.064***	4.263*	1.536**	0.524	1.777**	1.978**	4.203*	1.042*	0.536*
	(0.912)	(0.866)	(2.318)	(0.645)	(0.330)	(0.857)	(0.813)	(2.249)	(0.600)	(0.296)
log GDP	1.533***	1.573***	1.639***	0.575	1.444***	1.649***	1.639***	1.524***	0.882	1.391***
	(0.477)	(0.491)	(0.503)	(0.840)	(0.552)	(0.406)	(0.420)	(0.449)	(0.828)	(0.490)
log dist	5.568***	4.892***	5.908***	7.221***	6.063***	4.055***	3.609***	4.207***	5.053***	4.003***
	(1.345)	(1.250)	(1.336)	(1.507)	(1.406)	(1.378)	(1.260)	(1.366)	(1.542)	(1.425)
Obs.	9127338	9148275	9122304	8007406	8788547	8263809	8280354	8259143	7247785	7951321
R^2	.807	.807	.808	.816	.808	.83	.83	.83	.837	.83
ΔM	7.723	9.726	4.263	6.819	4.364	4.393	6.285	4.203	4.626	4.468

Note: Dependent variable is the trade credit maturity in days, M. First panel is the full sample. Second panel excludes prepaid transactions. All regressions include firm×product×year fixed effects. Robust standard errors are clustered at firm × destination level. *, **, *** represent significance at 10, 5 and 1% respectively.

To test the competition effect on trade credit maturity, I will estimate the following equation.

$$M_{fpdt} = \beta X_{fpdt} + \boldsymbol{\nu' Z_{ft}} + \gamma_{pdt} + \varepsilon_{fpdt}, \tag{3.25}$$

where X_{fpdt} will capture competition. Following the discussion of institutions, I will include product×destination×year fixed-effects to control for market and product characteristics. Z_{ft} will control for firm characteristics. As previously mentioned, I should expect that high levels of competition imply longer trade credit periods. Since measuring competition is hard, I will use two approaches. The first one uses the product complexity index (PCI), a product-year specific metric constructed by Hausmann et al. (2014) at HS 4-digit level. In a nutshell, this measure captures how complex a product is, where complexity is defined by the ubiquity of the product (how many countries produce the same thing) and the diversity of products that a given country produces.[38] Therefore, a highly complex product will be something that few countries produce and these countries have a very diversified production matrix. Based on this definition, it is natural to expect that highly complex product faces less competition, therefore using this specification, I expect $\beta < 0$.

Table 3.14 describes the results of these estimations. For robustness, I included specifications with firm controls, firm FE and also a specification where I excluded CIA transactions. As expected, I find a negative relationship between product-complexity/competition and trade credit, where more complex products have between 18 to 50 days less of trade credit.

To complement this approach, I will use standard measures of competition. First, I will compute the Herfindahl-Hirschman Index (HHI) for each market, where a market will be defined as a product-destination-year combination. Through HHI, I measure the competition among Chilean exporters, not competition with the rest of the world. For a broader notion of competition, I will use the market share that a given firm has in a particular product-destination-year. This share will be computed over all the imports (not just of Chilean origin) of a country for a said product in a year obtained from UN COMTRADE. In other

[38] The actual measure is computed through, as it is known in network theory, the eigenvector centrality.

Table 3.14: Trade credit and competition - PCI

	Full Sample			$M > 0$		
	(1)	(2)	(3)	(4)	(5)	(6)
PCI	-12.566***	-12.601***	-1.424	-15.718***	-16.105***	-5.520***
	(2.971)	(2.800)	(1.172)	(4.421)	(4.450)	(2.108)
Obs.	9167764	7661709	9156757	8304905	6983374	8299140
R^2	.423	.45	.794	.438	.466	.819
Prod-2d×Dest×Year FE	✓	✓	✓	✓	✓	✓
Firm Controls		✓			✓	
Firm×Year FE			✓			✓
ΔM	-42.7	-43.2	-4.83	-52.8	-54.6	-18.5

Note: Dependent variable is the trade credit maturity in days, M. Firm controls include log employment, log equity and log Age. First panel is the full sample. Second panel excludes prepaid transactions. Robust standard errors are clustered at firm × destination level. *, **, *** represent significance at 10, 5 and 1% respectively.

words, market share is calculated as:

$$\mathrm{s}_{fpdt} = \frac{\mathrm{Sales}_{fpdt}}{\mathrm{Imports}_{pdt}}$$

As before, large HHI and large market share imply that the firm faces less competition. Thus I expect $\beta < 0$. Regarding this latter approach, other forces may explain this correlation. For example, a firm may use trade credit as a marketing strategy to increase its market share. This strategy implies that low market share firms will extend longer trade credit periods to increase their share, delivering the expected negative correlation. Alternatively, since large firms, with large market shares, produce high-quality goods, a positive correlation could also be found.[39] To address these issues, in a third specification, I will instrument the current market share by the previous year's market share of the same firm-product-destination. Table 3.15 shows the results of these estimations. The coefficient of interest is negative, as expected. Moreover, the magnitude of the competition seems important. On average, as we approach the monopoly case, firms provide 35 days less of trade credit. Notice that in both specifications, PCI and market share, when using the full sample, the results are dampened,

[39]Both arguments do not deliver a direct sign of the bias in the estimation.

compared to the restricted sample of only trade credit transactions. This effect speaks to the idea that competition drives the intensive margin of trade credit more than the extensive margin, at least in the context of international trade.[40]

Table 3.15: Trade credit and competition - Market Share

	Full Sample			$M > 0$		
	HHI	Market Share	Market Share$_{IV}$	HHI	Market Share	Market Share$_{IV}$
Competition	-26.394***	-22.848*	-37.770**	-35.292***	-32.559*	-45.672**
	(6.848)	(12.548)	(15.678)	(8.781)	(17.610)	(20.973)
Obs.	7886285	7008117	5717810	6381860	6381860	5259124
R^2	.453	.463	.477	.484	.482	.5
F-stat			14491.6			12847.8

Note: Dependent variable is the trade credit maturity in days, M. All regressions include firm controls: log employment, log equity and log age and Product-2d$\times$Destination$\times$Year fixed effects. First panel is the full sample. Second panel excludes prepaid transactions. Robust standard errors are clustered at firm $\times$ destination level. *, **, *** represent significance at 10, 5 and 1% respectively.

Finally, prediction 3 states that products that, in principle, require more time to verify their quality (i.e., low μ) will have a longer trade credit period. To capture the notion of quality assessment, I will turn my attention to the Rauch (1999) classification of differentiated products used in the quality estimation. The hypothesis is that it is harder to verify quality for differentiated goods. Therefore, these products will have longer trade credit periods than the homogeneous/referenced priced goods. To test this prediction, I will estimate (3.25), where X_{fpdt} will be a dummy variable equal to one if the product is differentiated according to Rauch (1999), zero if not. Table 3.16 shows the result of the estimation. For the sake of comparison, I estimate a version that only includes destination-year fixed effects. In this case, differentiated products have a shorter trade credit maturity, which is similar to the competition estimation.[41] Once I control for the type of product (HS 2-digit), the relationship flips and differentiated goods have 5 to 20 days longer trade credit periods.

[40] This result does not contradict what Demir and Javorcik (2018) found. In their case, exporters are choosing mainly between OA and DC, which fundamentally are two different forms of trade credit.

[41] The correlation between the differentiated product dummy and PCI (market share) is 0.25 (0.23)

Table 3.16: Trade credit and quality verifiability

	Full Sample			$M > 0$		
	(1)	(2)	(3)	(4)	(5)	(6)
Diff	-21.005***	23.215***	5.498**	-19.220**	22.010***	5.638**
	(6.241)	(7.206)	(2.550)	(7.643)	(6.552)	(2.457)
Dest×Year	✓			✓		
Firm Controls		✓			✓	
Prod-2d×Dest×Year		✓	✓		✓	✓
Firm×Year			✓			✓
Obs	9464609	7886285	9448375	8535148	7162498	8524639
R^2	.141	.454	.795	.128	.469	.82

Note: Dependent variable is the trade credit maturity in days, M. Firm controls include log employment, log equity and log Age. First panel is the full sample. Second panel excludes prepaid transactions. Robust standard errors are clustered at firm × destination level. *, **, *** represent significance at 10, 5 and 1% respectively.

3.5.3 Additional results

Implied interest rate

Although not a direct implication of the model, using this data set, I can calculate the implied average interest rate for trade credit. To do this, I follow Schwartz (1974), where the price under trade credit corresponds to an original price (CIA) corrected for an interest rate. In other words:

$$P^{TC} = (1+r)^M P^{CIA} \tag{3.26}$$

For a more parsimonious estimation and to avoid issues like price seasonality and price variation due to exchange rate fluctuations, I will estimate the model at the annual level. This means that, for a given firm, I will define a transaction as the sum of all quantities exported of a product to a particular destination in a specific year, for a given payment method. Following this, I will compute the average annual price of said transaction. Finally, as for the trade credit maturity M, I will use the FOB-weighted trade credit maturity.

To compute the average interest rate relevant for trade credit, I will estimate the following equation, for exporters and importers.

$$\log p^c_{fpdt} = \beta X_{fpdt} + \gamma_{fpdt} + \varepsilon_{fpdt}, \text{ where } c \in \{CIA, TC\}, \tag{3.27}$$

where X will be either a dummy equal to 1 if the transaction is paid under some form of trade credit or directly the trade credit maturity M, and γ_{fpdt} is a set of firm×product×destination×year fixed effects. The identification is given by the difference in price from a firm selling the same product to a particular destination in a year under two different modes (trade credit and *cash-in-advance*) with their different maturities.

Note that equation (3.27) can be obtained by taking logarithms on both sides of (3.26), in that case $\beta = \log(1 + r) \approx r$ and $\log P^{CIA}$ will be captured by the set of fixed effects that will capture supply and demand factors that might affect the fundamental price.

Table 3.17: Prices and trade credit

	Exports				Imports			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$I(TC = 1)$	-0.033**	0.092**			-0.066**	0.042**		
	(0.009)	(0.011)			(0.004)	(0.004)		
M (in years)			-0.059**	0.223**			-0.306**	0.323**
			(0.021)	(0.024)			(0.018)	(0.016)
$\log q$		-0.148**		-0.146**		-0.231**		-0.235**
		(0.007)		(0.007)		(0.002)		(0.002)
Obs.	52818	52818	52818	52818	897984	897984	897984	897984
R^2	.961	.966	.961	.966	.937	.953	.937	.953

Note: Dependent variable is log price. All regressions include firm×product×country×year fixed effects. First panel is Exporters sample, second panel corresponds to the importers panel. Robust standard errors are clustered at firm × destination level. *, **, *** represent significance at 10, 5 and 1% respectively.

Table 3.17 shows the estimation results. I divided M that was originally in days by 365. Thus β will be a measure of the annual interest rate for trade credit. Columns (1) and (3) for exporters and (5) and (6) for importers show the results from estimating (3.27) directly. The results are counter-intuitive since they show that prices are lower under trade credit. One issue with this simple model is that it might omit quantity discounts that firms may offer[42] and because trade credit transactions are related to larger volumes, this can bias the estimations. Columns (2), (4), (6), and (8) control by the volume of a given transaction. These results indicate that trade credit has an implied interest rate of 22% to 28% (25% to 32%) on average for exporters (importer).[43] This interest rate is quite large compared to the lending rate in US dollars obtained in the Chilean financial sector[44] but is comparable to other estimates related to trade credit, see Petersen and Rajan (1997), Cuñat and Garcia-Appendini (2012), and Breza and Liberman (2017) for similar calculations.

Trade Credit and Relationship

Another point stressed by the literature is the importance of the relationship between producer and retailer in the provision of trade credit. This issue has been discussed by Antras and Foley (2015), García-Marín, Justel, and Schmidt-Eisenlohr (2019), and Justel (2019). Using the exporters' data set, I can test the effect of repeated transactions on the likelihood of trade credit and the number of days of trade credit. One of the drawbacks of the data set is that it does not include information to identify the foreign buyer, in the case of exports, and the foreign seller for imports. Because of this, I will consider a transaction as a combination of firm-product-country.

To study this effect, I follow Piveteau (2019) in his identification strategy. I estimate the following equation.

$$Y_{fpdt} = \beta \log \text{Transactions}_{fpdt} + \gamma_{pdt} + \gamma_{fpt} + \varepsilon_{fpdt}, \tag{3.28}$$

where Y will be trade credit maturity or a dummy variable equal to 1 if the transaction is *cash-in-advance*. γ_{pdt} captures demand effects that can affect the dependent variable (quality of institutions, for example), and γ_{fpt} will control for supply-side factors (product quality,

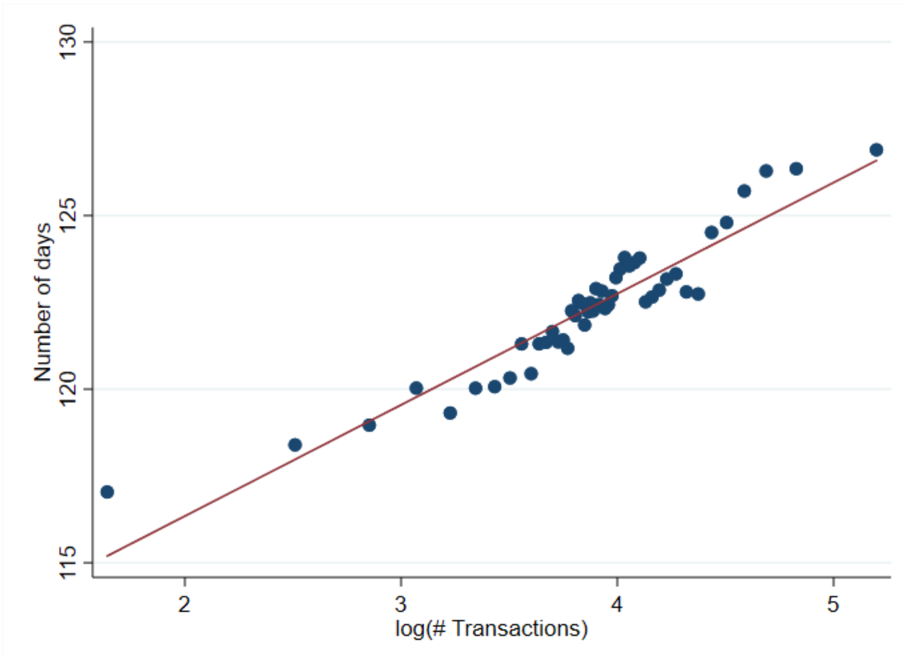
[42]This point has been stressed out by Meleshchuk (2018)

[43]In this sample, trade credit has effective maturity of 120 days in the case of exporters and 70 days in the case of importers.

[44]The lending rate in the 2009-2017 period for credits in US dollars and period greater than 3 months and less than 6 months was on average 2.4%, with a maximum of 6.1 and a minimum of 1.4%

size, financial shocks). Figure 3.11 shows a graphical representation of the estimation. As the figure shows, there is a positive relationship between the number of previous transactions and the number of days of credit. Antras and Foley (2015), García-Marín, Justel, and Schmidt-Eisenlohr (2019), and Justel (2019), also find this pattern in the data, for the provision of trade credit. They justify this mechanism through learning.

Figure 3.11: Trade credit maturity and previous transactions



Note: Figure corresponds to binned scatter plot of number of days of trade credit vs. log Number of transactions. Both measures are demeaned at product×destination×year and firm×product×year level

The positive relationship I find can be a mix of extensive and intensive margin effects. In order to disentangle these margins, table 3.18 shows the full estimation for different sub-samples or trade credit measures.

This table concludes that the number of transactions affects the extensive margin, the provision of trade credit, as previously found in the literature, but not the intensive margin, the number of days. Column (1) shows the positive relationship shown in figure 3.11. Once transactions under CIA are excluded, column (2) shows that there is no effect of transactions over the maturity of trade credit. To reinforce this idea, column (3) shows the same

Table 3.18: Trade credit maturity and relationship

Dep var	M	$M > 0$	$I(CIA = 1)$
log # Transactions	1.060**	-0.338	-0.009**
	(0.322)	(0.332)	(0.001)
Obs.	9329621	8435089	9653891
R^2	.844	.863	.734

Note: All regressions include product× destination×year and firm×product×year fixed effects. Robust standard errors are clustered at firm × destination level. *, **, *** represent significance at 10, 5 and 1% respectively.

estimation but using an indicator for a *cash-in-advance* transactions. This column indicates that the number of transactions decreases the likelihood of CIA (alternatively, increases the probability of trade credit provision). It is worth noting that, due to the shape of the log function, the effect of the first number of transactions is very sharp, but it vanishes as the number of transactions increases.

3.6 Conclusion

In this paper, I developed a model in which trade credit has two objectives. It serves effectively as a product quality guarantee and, simultaneously, trade credit acts as a signal of the quality of the good.

In the model, similar to Long, Malitz, and Ravid (1993), product quality, known by the producer, is not observable by the buyer, but it can be verified over time before payment. So, the buyer can use the trade credit period to certify the quality of the product. In this theoretical framework, I show that firms producing low-quality goods will sell with payment in advance, whereas high-quality goods producers will extend trade credit. Additionally, I prove that higher quality goods have more extended trade credit periods.

In addition to the relationship between product quality and trade credit, the model delivers a set of testable predictions. Specifically, the theory suggests firms selling in countries with better legal institutions (e.g., the rule of law, contract enforcement) and in markets with the tougher competition will offer more extended trade credit periods. Also, the model predicts that firms producing goods that require a long time to verify quality will provide longer trade credit periods as well.

I empirically test the mechanism and predictions of the model using transaction-level data for exporters obtained from the Chilean Customs Agency. Trade credit is commonly used in international trade, and this detailed data set includes a variable that captures the in how many days a given transaction will be (was) paid. For quality measures, I use two strategies. Initially, I take and off-the-shelf methodology from Khandelwal, Schott, and Wei (2013) to estimate quality from the data set. Then, for robustness, I focus my attention on the wine industry in Chile. I use this industry because several widely accepted proxies for wine quality can be obtained from the internet (e.g., ratings, awards, retail price, among others).

I find evidence consistent with the proposed model. As for the main mechanism, I find that high-quality goods are 8% more likely to be traded under trade credit compared to low-quality goods. Moreover, high-quality products have, on average, 20 more days of trade credit.

The additional predictions are also corroborated. Countries with better legal institutions have five days longer trade credit periods, firms that face higher competition provide 20 to 50 days more of trade credit, and products for which quality is hard to asses have 5 to 20 days longer maturities.

I also find that the implied annual interest rate of trade credit is 25%, on average, quite high compared to the financial sector, but comparable to other estimations. Additionally, I find that repeated interactions affect the decision to provide trade credit, as previously seen in the literature. However, these interactions do not alter the maturity of the trade credit.

This model and its results imply that trade credit is not purely a financial tool for a firm to get funding, thus explaining the significant difference between the commercial interest rate and the trade credit implied interest rate. Firms use trade credit to certify the quality of the goods they are buying, similar to a standard money-back guarantee. Therefore trade credit might be favorable for firms since it allows trade.

This mechanism argues for a careful discussion from policymakers when planning for the regulations of trade credit. Countries like the U.S., France, and Chile have implemented policies that effectively cap the maturity of trade credit. Authors such as Barrot (2016) and Barrot and Nanda (2018) show that these policies have positive effects (more competition through entry increase and exit decrease, increase labor demand), but Breza and Liberman (2017) prove that these regulations could also have unintended consequences, namely trade reduction, in both intensive and extensive margin. An exciting avenue for future research is to embed these ideas into a general equilibrium model to study the welfare effects of regulation and how these effects are related to financial conditions, competition, and institutional framework.

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3.A Proofs

3.A.1 Sketch of a proof of proposition 7

The solution of the maximization problem defined by (3.15) can be obtained by solving the Lagrangian defined as follows:

$$\begin{aligned}\mathcal{L} = \left(w\mathrm{e}^{-(r+\delta^*)M} - c^H\right)\frac{\alpha^H - \eta Q - w\mathrm{e}^{-r^*M}}{2} + \sigma M \\ + \lambda\left[\Pi^L - \left(e^{-\mu M} w\mathrm{e}^{-(r+\delta^*)M} - c^L\right)\frac{\alpha^H - \eta Q - w\mathrm{e}^{-r^*M}}{2}\right].\end{aligned} \tag{29}$$

Where σ is the Lagrange multiplier for the restriction $M \geq 0$ and λ the multiplier related to the IC constraint. Taking first-order condition with respect to w and M and after some algebra, σ can be expressed as:[45]

$$\sigma = \frac{\alpha^H - \eta Q - w\mathrm{e}^{-r^*M}}{2} \frac{(c^H - c^L \mathrm{e}^{\mu M})w}{2w - (\alpha^H - \eta Q)\mathrm{e}^{r^*M} - c^L \mathrm{e}^{(r+\delta+\mu)M}} \left[(r + \delta - r^*) - \mu \frac{(2w - (\alpha^H - \eta Q)\mathrm{e}^{r^*M} - c^H \mathrm{e}^{(r+\delta)M})}{(c^H - c^L \mathrm{e}^{\mu M})} e^{-(r+\delta)M} \right] \tag{30}$$

From this expression, two things are worth noting. First, the term outside the brackets is always positive regardless of the value of μ or M. Secondly, the sign of the expresion inside the brackets depends on μ. For μ small enough, the term $(r + \delta - r^*)$ dominates, and because of the assumption $r + \delta^* > r^*$ the whole expression will be positive, which implies that $\sigma > 0$, which means that the restriction $M \geq 0$ is binding. Similarly, for sufficiently large μ, the brackets might turn negative, but because of the nature of Lagrange multipliers, this cannot happen. Therefore, for μ large enough, the only option for that expression is to be equal to zero. Thus $\sigma = 0$, meaning the restriction $M \geq 0$ is slack. This result implies that the producer optimally chooses to provide trade credit as part of its signal of quality.

Finally, using this last result, imposing $\sigma = 0$, I can solve for w obtaining (3.16) $\square$.

3.A.2 Existence of pooling equilibrium

Although the existence of the separating is guaranteed, the pooling equilibrium also may exist.

In a pooling equilibrium, low-quality and high-quality products will be sold under the same contract. To simplify the analysis, let me assume that in the pooling equilibrium, both goods are traded at $M = 0$.

Moreover, let me assume that the retailer knows there is a share λ of the population that

[45] The steps are: take FOC with respect to w and recover an expression for λ, then take FOC with respect to M and substitute λ for the previous expression. Finally, collect terms and solve for σ

sells high quality goods. Defining $\bar{\alpha} \equiv \lambda\alpha^H + (1-\lambda)\alpha^L$, with this, the demand from the retailer for a given wholesale price w will be

$$q(w) = \frac{\bar{\alpha} - \eta Q - w}{2\gamma}.$$

Focusing on the low-quality producer, for a given price of w, he has incentives to not deviate from the pooling equilibrium if

$$\Pi^L_{sep} \leq (w - c^L)q(w) \tag{31}$$

where Π^L_{sep} corresponds to the profits of the low quality producer in the separating equilibrium, given by (3.11). With this, a low-quality producer will not have incentives to deviate from the pooling equilibrium if

$$w \in \left[\frac{\bar{\alpha} - \eta Q + c^L}{2} - \frac{\sqrt{8\gamma(\Pi^{L,max}_{pool} - \Pi^L_{sep})}}{2}, \frac{\bar{\alpha} - \eta Q + c^L}{2} + \frac{\sqrt{8\gamma(\Pi^{L,max}_{pool} - \Pi^L_{sep})}}{2}\right] \tag{32}$$

where $\Pi^{L,max}_{pool} \equiv \frac{1}{8\gamma}(\bar{\alpha} - \eta Q - c^L)^2$ is the maximum profits a low quality producer can obtain under a pooling equilibrium.[46] Notice that since $\bar{\alpha} > \alpha^L$, the square root is well defined, therefore this interval is non-empty.

On the other hand, a high-quality producer faces a similar problem. This producer will not have incentives to deviate from the pooling equilibrium if

$$\Pi^H_{sep} \leq (w - c^H)q(w) \tag{33}$$

where Π^H_{sep} corresponds to the profits of the high quality producer obtained as the solution of (3.15)

By symmetry, a high-quality producer will not deviate from pooling if

[46] It corresponds to the profits as if low quality producer chooses his optimal price.

$$w \in \left[\frac{\bar{\alpha} - \eta Q + c^H}{2} - \frac{\sqrt{8\gamma(\Pi_{pool}^{H,max} - \Pi_{sep}^H)}}{2}, \frac{\bar{\alpha} - \eta Q + c^H}{2} + \frac{\sqrt{8\gamma(\Pi_{pool}^{H,max} - \Pi_{sep}^H)}}{2} \right] \quad (34)$$

where $\Pi_{pool}^{H,max} \equiv \frac{1}{8\gamma}(\bar{\alpha} - \eta Q - c^H)^2$. In this case, the condition for a non-empty interval is not guaranteed. The following lemma summarizes these results.

Lemma 2. *If $\Pi_{pool}^{H,max} < \Pi_{sep}^H$ the pooling equilibrium does not exist.*

On the other hand, a pooling equilibrium exists for a given wholesale price w only if

- $\Pi_{pool}^{H,max} \geq \Pi_{sep}^H$,
- $A \cap B \neq \phi$, *where A and B are the sets defined by (32) and (34) respectively and*
- $w \in A \cap B$.

Since firms may use prices and trade credit to deviate, the existence of the pooling equilibrium is not guaranteed. In the case that firms only use prices to separate, the pooling equilibrium will exist if λ is sufficiently large. Intuitively, if the retailer believes that a large part of the firms is of high-quality, the low-quality firm has incentives to pool. Moreover, since λ is big enough, the expected demand is close to the perfect information demand for the high-quality product and high-quality firm (that only uses prices as signal) will not pay the cost of signaling in the pooling equilibrium.[47]

3.A.3 Trade credit, quality and competition

Assuming two levels of quality, combining (3.16) and (3.17) and assuming, for simplicity, $c^L = 0$, the IC constraint can be written as:

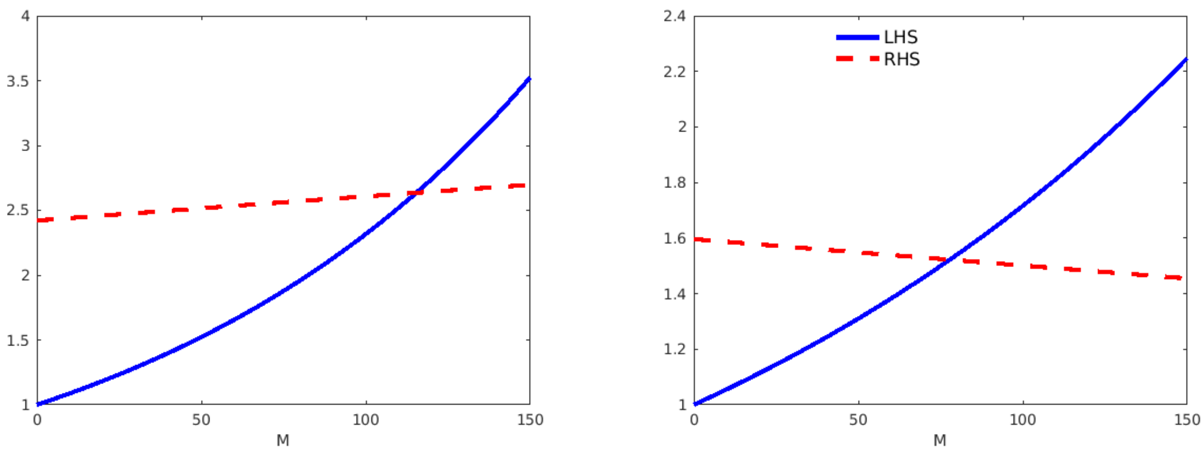
$$8\gamma\Pi^L = (\alpha^H - \eta Q)^2 e^{-(r+\delta^*+\mu-r^*)M} - c_H^2 \left(1 + \frac{r + \delta^* - r^*}{\mu}\right)^2 e^{(r+\delta^*-\mu-r^*)M}$$

[47]Remember that when high-quality firms only use prices to signal quality then $\Pi_{sep}^H < \Pi_{sep}^L$, guaranteeing the non-empty intersection.

Using the fact that $8\gamma\Pi^L = (\alpha^L - \eta Q)^2$, then M is defined as the solution of

$$e^{(r+\delta^*+\mu-r^*)M} = \frac{(\alpha^H - \eta Q)^2}{(\alpha^L - \eta Q)^2 + c_H^2 \left(1 + \frac{r+\delta^*-r^*}{\mu}\right)^2 e^{(r+\delta^*-\mu-r^*)M}} \tag{35}$$

Figure 3.A.1: Solution of the model



(a) $\mu > r + \delta + r^*$

(b) $\mu < r + \delta + r^*$

Note: Solid line corresponds to the left side of (35) and dashed line to the right hand side.

As figure 3.A.1 shows the LHS is upward sloping, whereas the RHS is upward (downward) sloping if $\mu >$ (<) $r + \delta - r^*$. A couple of things worth noting. First, since the LHS is unbounded, whereas the RHS is bounded as $M \to \infty$[48], $M > 0$ only if $(\alpha^H - \eta Q)^2 \geq (\alpha^L - \eta Q)^2 + c_H^2 \left(1 + \frac{r+\delta^*-r^*}{\mu}\right)^2$. Secondly only the right-hand side depends explicitly on quality (c_H, α^H) and competition (ηQ). Therefore, provision of trade credit, the relationship between M and quality and the relationship between M and competition are completely defined by (35) and are described in the following lemmas.

Lemma 3. *If μ sufficiently high then $M > 0$*

Lemma 4. *If quality increases then M increases.*

[48]Either this expression goes to 0 or $\left(\frac{\alpha^H - \eta Q}{\alpha^L - \eta Q}\right)^2 > 0$ depending on $\mu <$ (>) $r + \delta - r^*$.

Lemma 5. *If $\mu \geq r + \delta - r^*$ and $\Delta\alpha > \frac{c_H^2}{\alpha^L}\left(1 + \frac{r+\delta^*-r^*}{\mu}\right)^2$ then M increases with ηQ for $\eta Q \in [0, \kappa]$, for some $\kappa < \alpha^L$*

The proof of the lemma 3 comes from the fact that since $\Delta\alpha > \Delta c = c_H$, then for μ sufficiently high, $\Delta\alpha > c_H\left(1 + \frac{r+\delta^*-r^*}{\mu}\right)$, adding $\alpha^L - \eta Q$ on both sides and squaring them, I find the condition for $M > 0$. Similarly, lemma 4 relies on $\Delta\alpha > \Delta c$. Meaning, as we increase quality, the cost does not increase as much, then the increase in the numerator will always be greater than the increase in the denominator. Then, the RHS of (35) shifts up, delivering a larger M $\square$.

The proof of the final lemma is less intuitive and I need to calculate the derivative of the RHS of (35) with respect to ηQ. Then, this expression will be increasing in ηQ if $\Delta\alpha > \frac{c_H^2}{\alpha^L-\eta Q}\left(1 + \frac{r+\delta^*-r^*}{\mu}\right)^2 e^{(r+\delta^*-\mu-r^*)M}$ and it will be decreasing otherwise.

The former condition will be satisfied for values of $\eta Q \in [0, \kappa]$ if $\mu \geq r + \delta - r^*$ and $\Delta\alpha > \frac{c_H^2}{\alpha_L}\left(1 + \frac{r+\delta^*-r^*}{\mu}\right)^2 \square$.

In other words, lemma 3 states the existence of the separating equilibrium for a sufficiently high μ. The next lemma describes the fact that trade credit maturity (and with more reason wholesale prices) are increasing as the traded good is of higher quality. This increasing signal deters the low-quality firm from mimicking the increasingly higher quality producer.

The final lemma says that if the difference in quality is sufficiently high or the rate of which information of bad quality arrives is high enough, firms that face tougher competition will provide more extended trade credit periods. Notice that this condition will fail for sufficiently high levels of competition (the term $\frac{c_H^2}{\alpha_L-\eta Q}$ grows with ηQ), thus the non-monotonic relationship between competition and trade credit maturity.

3.B Additional Tables

Table 3.B.3: Trade credit maturity and quality - Firm size

	$\sigma = \sigma_p$	$\sigma = 5$	Rating	Avg Rating	log price	log Avg price	Award	Bulk
Quality	3.652**	0.872	0.941	1.592*	1.561	3.773**	10.530***	-13.403**
	(1.829)	(1.415)	(0.874)	(0.852)	(1.813)	(1.691)	(2.178)	(5.520)
$\log N$	4.210***	5.876***	7.464***	8.057***	10.662***	8.569***	5.668***	6.179***
	(1.400)	(1.728)	(2.520)	(2.568)	(2.367)	(2.412)	(1.950)	(1.999)
Obs.	1529460	1531287	894492	910119	752403	1120481	1531896	1531896
R^2	.189	.186	.208	.225	.314	.226	.19	.187
ΔM	30.562	7.780	9.406	15.918	5.561	12.463	10.530	-13.403

Note: Rating and price corresponds to the rating and final price of a particular wine-vintage. Avg Rating and Avg price are respective average ratings and final prices for a wine over vintages. Award and Bulk are dummy variables with value 1 if wine earned an award or if it is a bulk wine. All regressions include grape×destination×year fixed effects. Robust standard errors are clustered at firm × destination level. *, **, *** represent significance at 10, 5 and 1% respectively.

Table 3.B.4: Trade credit maturity and quality - Excluding CIA transactions

	$\sigma = \sigma_p$	$\sigma = 5$	Rating	Avg Rating	log price	log Avg price	Award	Bulk
Quality	2.599	0.813	0.983	1.604*	1.622	3.901**	10.682***	-15.167***
	(1.965)	(1.531)	(0.912)	(0.895)	(1.866)	(1.757)	(2.246)	(5.513)
$\log N$	3.978***	5.082***	6.795***	7.454***	10.146***	7.949***	4.837**	5.336**
	(1.483)	(1.821)	(2.623)	(2.667)	(2.455)	(2.509)	(2.058)	(2.112)
Obs	1466235	1468024	864234	880313	730753	1082685	1468574	1468574
R^2	.18	.179	.207	.224	.315	.224	.183	.18
ΔM	21.482	7.100	9.833	16.035	5.779	12.885	10.682	-15.167

Note: Rating and price corresponds to the rating and final price of a particular wine-vintage. Avg Rating and Avg price are respective average ratings and final prices for a wine over vintages. Award and Bulk are dummy variables with value 1 if wine earned an award or if it is a bulk wine. All regressions include grape×destination×year fixed effects. Robust standard errors are clustered at firm × destination level. *, **, *** represent significance at 10, 5 and 1% respectively.

Table 3.B.5: Quality and Likelihood of Trade Credit - Month

	$\log N$	$\sigma = 5$	$\sigma = 10$	$\sigma = \sigma_p$
Quality	-0.008***	-0.008***	-0.003***	-0.003***
	(0.001)	(0.002)	(0.001)	(0.001)
Obs.	8616460	2276519	2276519	2006583
R^2	.563	.702	.701	.707
$\Delta I(CIA = 1)$	-0.064	-0.180	-0.135	-0.096

Note: All regressions include product×destination×year×month fixed effects. σ_p is the product-specific elasticity estimated by Broda and Weinstein (2006). $\log N$ is corresponds to the log of employment. Robust standard errors are clustered at firm × destination level. *, **, *** represent significance at 10, 5 and 1% respectively.

Table 3.B.6: Trade credit maturity and quality - Month

	$\log N$	$\sigma = 5$	$\sigma = 10$	$\sigma = \sigma_p$
Quality	2.593***	1.323***	0.423***	1.178***
	(0.775)	(0.286)	(0.135)	(0.230)
Obs.	8616460	2276519	2276519	2006583
R^2	.655	.723	.723	.737
ΔM	22.109	31.509	20.583	37.973

Note: All regressions include product×destination×year×month fixed effects. σ_p is the product-specific elasticity estimated by Broda and Weinstein (2006). $\log N$ is corresponds to the log of employment. Robust standard errors are clustered at firm × destination level. *, **, *** represent significance at 10, 5 and 1% respectively.

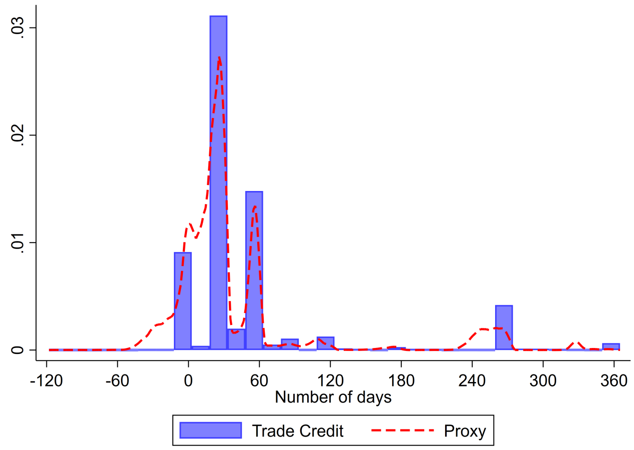
Table 3.B.7: Trade credit maturity and transportation mode

	Full Sample		$M > 0$	
	(1)	(2)	(3)	(4)
Air	-5.939***	-5.117***	-4.292**	-3.951**
	(1.952)	(1.929)	(1.944)	(1.921)
Ground	-12.646***	-11.763***	-9.673***	-9.289***
	(3.101)	(3.195)	(3.138)	(3.247)
Rest	-5.580	-7.600	-6.455	-1.135
	(6.306)	(8.147)	(6.884)	(9.032)
$\log q$		0.571***		0.207
		(0.219)		(0.212)
Obs	9360070	9073179	8461144	8220031
R^2	.81	.807	.833	.83

Note: The benchmark transportation mode is waterborne. Air is a dummy variable that is equal to 1 if the product was transported by air. Ground will be 1 if the good was transported by land. Rest will be 1 if is the good is transported by alternatives like a pipeline or train. These products are minimal. All regressions include firm×product×year and destination×year fixed effects. Robust standard errors are clustered at firm × destination level. *, **, *** represent significance at 10, 5 and 1% respectively.

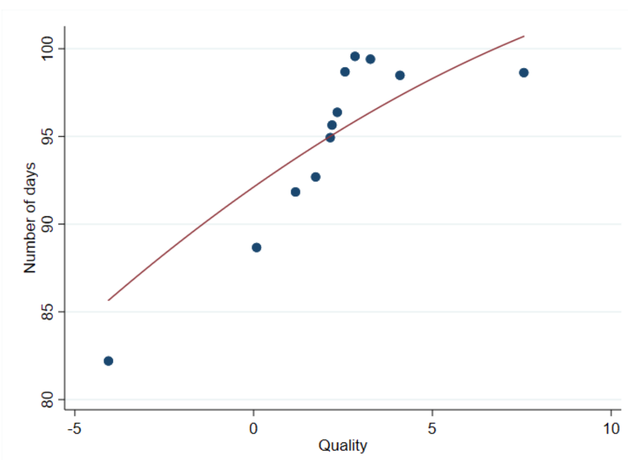
3.C Additional Figures

Figure 3.C.1: Trade credit maturity and proxy

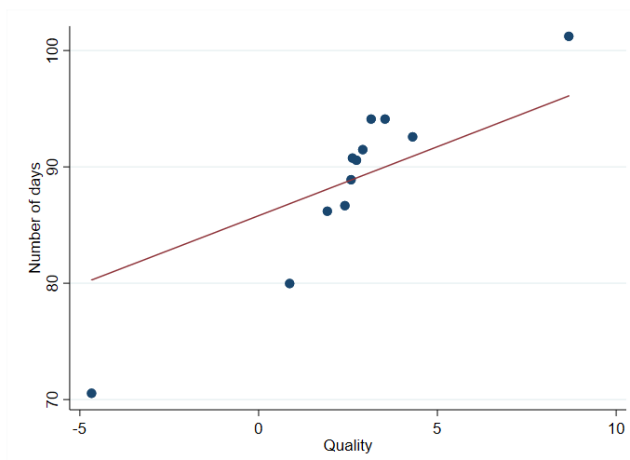


Note: The bars represent the exact trade credit period for a subsample and the dashed-line is the distribution of the measure of trade credit used throughout the paper.

Figure 3.C.2: Trade credit maturity and quality - Including months



(a) $\sigma = 5$



(b) $\sigma = \sigma_p$

Note: Both figures are binned scatter plots of number of days of trade credit vs. quality measured as the residual of (3.20) demeaned by product×destination×year×month. Left panel estimates quality using demand elasticity of 5 and right panel using the demand elasticity estimated by Broda and Weinstein (2006)